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TABLE OF CONTENTS:

ENGINEERING NEWS OF THE WEEK..... 97
Steam Excavating and Grading Machine (illustrated). 98
Comparison of Formulas for Flow of Water in Cast-Iron Pipes 98
A Novel Way of Constructing a Derrick (illustrated). 99
Diagrams for Calculating the Safe Load on Cast-Iron Columns According to the New York Building Code (illustrated)..... 99
Notes from the Engineering Schools..... 100
The Redridge Dam (with two-page plate)..... 101
Packing Goods for Export..... 102
Locomotive Coal and Ashes Handling Plant, Philadelphia & Reading Ry., Philadelphia, Pa. (illustrated)..... 102
Experiments on Winter Irrigation of Deciduous Orchards in Southern Arizona..... 103
Machine for Loading Box Cars (illustrated)..... 108
The Decomposition of Cement by Sea Water..... 108
Water-Works for the C. R. Baird Co.'s Iron Mines at Ogden, Va. (illustrated)..... 110
Effects of Dams and Like Obstructions in Silt-Bearing Streams (illustrated) 110
Preliminary Conclusions of the British Royal Commission on Sewage Disposal..... 111
Naval and Merchant Ship Construction in the United States During the Past Year..... 112
Book Reviews 112
EDITORIAL NOTES..... 104
Water Purification Investigation for St. Louis—The Preliminary Conclusions of the Royal Commission on Sewage Disposal.
EDITORIAL:
The Use of Concrete in Railway Structures..... 104
LETTERS TO THE EDITOR 106
The Advantages of Concrete as Compared with Rubble Masonry—An Optical Illusion (illustrated)—The Relative Cost of Solid Fill and Creosoted Pile-Supported Piers (illustrated)—Australian Hardwood and Creosoted Deal Pavements in London—Holbrook's Spiral Curves (illustrated).

THE BRIDGE OVER THE AMOU-DARIA RIVER, in Russian Central Asia, was opened for traffic on June 10, 1901. This is the largest bridge in the Russian Empire and replaces a timber trestle 1½ miles long by which the Mid-Asiatic Railway previously crossed the river named. The following brief description of the new bridge has been furnished to us by Mr. A. Zdziarski, Engineer of Ways and Communications, St. Petersburg, Russia:

Toward the end of 1897 the construction of a permanent metallic bridge was intrusted to a special commission, presided over by K. Mikhailovski, C. E., and in May of 1898 the Chief Engineer, S. Olszewski, with his staff, was commissioned to elaborate the design and choose the system of foundations. This preliminary work was carried out during the winter of 1898-9, and at the beginning of 1899 the design and estimates were ready. The cost was established at about $2,700,000. The bridge consists of 25 spans of 210 ft. each and two spans of 35 ft. on abutments. The total opening of the bridge is 5,250 ft. The foundations of the piers were sunk by means of dredged pits, the soil being removed by means of English and American blade-excavators. Each pier consists of two columns covered with iron sheets. The superstructure consists of triangular lattice girders. It is 21 ft. above the high-water level. The total weight of iron employed was about 8,000 tons, of which 5,200 tons were for the superstructure, 2,100 tons for piers, and 700 tons for the iron deck. Most of the iron was furnished by the Briansk Iron Works, and only a small part by the Rudzki Works in Warsaw, and the Marioupol Metallurgic Society. The volume of masonry is about 20,000 cu. yds., and is all porphyritic limestone from the Ziadin quarry, 120 miles from the bridge, near the Ziadin railway station. The superstructure was erected by the Briansk Works as contractors. The piers and abutments were built directly by the chief engineer. The bridge is lighted by electricity. The bridge was tested by a commission, presided over by Professor Belelonbsky, and gave satisfactory results.

A BRIDGE OVER THE UROU RIVER, near the Winter Palace, St. Petersburg, Russia, is planned to replace the old pontoon bridge now in use. The new structure will, it is stated, be 847 ft. long and 91 ft. wide and its cost is limited to $1,802,500. The specifications will be ready for builders on Sept. 1 and the bridge must be completed in one year from that date.

THE FIRST STEEL BRIDGE IN MIDDLE YUKON has been formally opened for traffic. It spans the Klondike River, nearly opposite the mouth of Bonanza Creek, or about a mile and a half above its junction with the Yukon at Dawson. The main span is 154 ft. long and rests on steel caissons filled with cement, and strengthened with crib and rock work. The total cost of the bridge in position was $30,000. It was built by the Dominion Bridge Co., of Montreal, and put in place under the superintendence of Mr. Thibadeau, Civil Engineer, and Mr. D. Matheson. It was named the Ogilvie Bridge, in honor of the retiring gold commissioner, to whom its building was due. It was tested by a large body of Northwest mounted police marching over it in step.

SPECIFICATIONS FOR STRUCTURAL STEEL are under consideration by the Committee on Iron and Steel Structures of the American Railway Engineering and Maintenance-of-Way Association, and a circular has been issued asking for information on certain points as noted below:

Should the limits of phosphorus for open-hearth rolled steel be 0.06 or 0.04% for basic, or 0.08 or 0.06% for acid steel. What limits are to be recommended?

Should the limit of sulphur in both acid and basic open-hearth steel be 0.06 or 0.05%, or what limit should be recommended.

Since soft steel is generally used without reaming or planing, would it not be advisable to require the bending tests of soft steel to be made on specimens having sheared edges unplaned, the specimens to be capable of bending in either direction flatwise. If so, what angle of bending should be required?

What should be the ranges of tensile strength for rolled steel:

Rivet steel: 50,000 to 60,000 lbs.; or 48,000 to 56,000 lbs.
Soft steel: 52,000 to 62,000 lbs.; or 52,000 to 60,000 lbs.
Medium steel: 60,000 to 70,000 lbs.; or 60,000 to 68,000 lbs.

INTERESTING STATISTICS, relating to the water-works of Chicago, are included in the July bulletin, published by the Chicago Municipal Library and Bureau of Statistics. The table covers the period from 1854 to 1900, inclusive, and was compiled by Mr. J. H. Spangler, Assistant City Engineer of Chicago. According to the table the average daily pumpage for the year 1900 was 322,599,630 gallons. By using a school census estimate of population this is made to show a per capita consumption of 161 gallons, but if instead of the 2,007,695 thus obtained the 1900 census figures of 1,698,575 is used as a divisor the per capital consumption mounts up to 190 gallons a day. But this is 32 gallons less than the consumption in Philadelphia, as given in our issue of Aug. 8. The total daily capacity of the Chicago works is placed at 528,375,000 gallons in 1900. Of the 308,945 taps in use only 6,396 are metered; and yet the revenue from metered water was $1,144,644 in 1900, out of a total of $3,250,482. In other words, about 2% of the taps yielded some 35% of the revenue. The revenue per 1,000,000 gallons pumped has fallen from $66.52 in 1855 to $27.57 in 1900. The "total average cost" of lifting 1,000,000 gallons of water 1 ft. has fallen from 8.64 cts. in 1861 to 4.79 cts. in 1900. In 1864 this cost was 18.40 cts.; and in 1899 it was down to 4.05 cts.

THE LAKE BORGNE CANAL has been completed at or near New Orleans. It connects the Mississippi River with Mississippi Sound and, it is said, will make a new channel of water communication between the Mississippi River system and the Mobile, Alabama and Warrior rivers. The canal proper is only three miles long. It is quite deep and has one or more locks. It was opened about 1880, but was allowed to get out of repair and finally closed. The canal is now owned by the Lake Borgne Canal Co.

STREET SWEEPING BY TROLLEY is reported as under trial at Cleveland, O. It is said that an 8-ft. broom sweeps the space between and just outside the rails and that a 16-ft. broom sweeps at the side. Credit for the application of sweepers to street cars is given to Mr. I. A. McCormick, General Manager of the Cleveland Electric Railway Co.

AN OVERWHELMING DEFEAT for sewage disposal at Columbus, O., we regret to say, was the result of the election on Aug. 3. The vote was on the question of issuing $2,250,000 of bonds for septic tanks, intermittent filter beds, intercepting sewers and pumping stations. Of a total registration of 36,258 only 5,671 took the trouble to vote, and of the latter only 1,537 voted for the bonds. At the same election a proposition to issue $200,000 to complete the municipal street lighting plant was defeated by a vote of 3,618 for and 2,215 against, a two-thirds majority being necessary. We are indebted to Mr. Julian Griggs, M. Am. Soc. C. E., Chief Engineer of the Department of Public Improvements, for the information on which this note is based.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear-end collision on the Baltimore & Ohio R. R. at Confluence, Pa., on Aug. 8. The Atlantic City express was running in three sections. The second section stopped at Confluence to take on a "helper" for the mountain grade, and while standing on an embankment on a sharp curve the third section, which was drawn by two locomotives, crashed into it. Fifteen people were seriously injured, three perhaps fatally. The blame for the accident has not yet been determined.

THE FAILURE OF A WATER TANK at Redwood Falls, Minn., occurred a few days ago. The tank was erected in 1892, and had a capacity of 90,000 gallons. The material is not stated.

A LARGE STEEL PLANT is being constructed by the Japanese Government. The following excerpt in regard thereto from the "Japan Daily Herald" is given by Consul-General Bellows, of Yokohama, in a recent report:

The Japanese Imperial Government, desiring to make the country independent of foreign aid in shipbuilding, railway construction, and the supply of military and naval requisites, has commenced work on a steel establishment, for which the government treasury has appropriated $7,056,425. The works will cover an area of 225 acres, and lie close to the shore of an excellent harbor in the northern part of Kyushu, ten miles distant from Moji. The grounds are connected by a branch line with the principal Kyushu railway, and are situated close to rich coal fields. There will be three departments, each under the joint direction of two engineers, one Japanese and one foreign. The pig-iron department will be fitted with coke-oven and blast-furnace plants, the steel department with mixed Bessemer and open-hearth plants and a steel foundry, and the rolling-mill department with roughing rail mill, large, middle and small bar mills, sheet mill, and large and middle plate mills, this department including seven subdepartments. It is intended to fit each department with all needed appliances for doing the best work. About one-third of the appropriation has already been expended, but the time when the works shall go into operation is not named. An iron foundry at Fukuoka, under the direction of Mr. Wada, is said to be very successful, and is turning out 100 tons of pig iron per day; and there are some very successful shipbuilding plants, but it is now necessary to import much of the raw material, and some of the fittings are manufactured abroad. The government has also lately opened an iron foundry at Wakamatsu, imported a large blast furnace, and expects to turn out about 120,000 tons of cast iron per year.

GRANITE PILLARS, 56 ft. long and 6 ft. in diameter, are being gotten out by the Bodwell Granite Co., of Vinalhaven, Me., for the Cathedral of St. John the Divine, now building in New York city. Attempts were at first made to get them out in one piece, but after breaking two upon the polishing lathe that plan was temporarily abandoned. The polishing lathe was made expressly for this undertaking and cost $50,000. A full-length pillar when finished will weigh about 125 tons.

THE GERMAN ANTARCTIC EXPEDITION, under the leadership of Prof. Ehrich von Drygalski, sailed from Kiel on Aug. 11. The German expedition will to some extent co-operate with the British expedition which sailed for the South on the steamship "Discovery" on Aug. 6. The British expedition will study the region from longitude 90° East to longitude 90° West, and the Germans will take the other half of the circle. Two other antarctic expeditions are to sail this year, a Swedish expedition under Dr. Otto Nordenskjöld, and a Scottish expedition under Dr. William S. Bruce. The "Gauss," the vessel in which the German party sailed, was specially built for the antarctic regions. She is entirely of wood and resembles Nansen's "Fram." She is especially strengthened by internal supports and a triple planking of oak and pitch-pine. She is 150 ft. long, draws 16 ft. of water, is rigged as a three-masted schooner and has engines which give her a speed of seven knots per hour.

ST. PAUL'S CATHEDRAL, in London, has been seriously damaged by the settlement of the foundations. Mr. Somers Clarke, the architect in charge, has published the following statement in the London "Times":

The immense weight resting upon the eight piers upholding the dome has caused the foundations under the dome to settle more than elsewhere. The settlement thus caused has broken eight arches and the windows of the clerestory over them, in the nave of the choir, and in the north and south transepts, where they abut on the dome piers.

In the same way the very great weight of the western towers has caused them to sink, and in sinking they have cracked the west front vertically through the Great Door, the window above, and the vaulted ceiling of the portico. They have also cracked the wall of the chapel to the east.

Mr. Clarke further expresses the opinion that the construction of two underground railways and the large sewers have seriously affected the foundations and he lays particular stress upon the effects of vibration caused by passing trains.

SHALLOW FOUNDATIONS of the "spread" type, composed of concrete and I-beam grillage construction, are being built for the new National Life Insurance Co. building on La Salle St., Chicago. After the site had been leveled off a little below the line of the old basement, the only excavation required was for the shallow rectangular pits for the foundation course of concrete under each column. Two courses of I-beams were laid on each bed and packed with concrete, the whole forming the base for the column shoes. The Geo. A. Fuller Co. has the contract for the superstructure.

THE GERMAN-ENGLISH-FRENCH TECHNICAL DICTIONARY, proposed some time ago by the Verein Deutscher Ingenieure, is now to be definitely taken up, the society having appointed Dr. Hubert Jansen to be Editor in Chief. The title of the work is to be "Technolexicon," and it will comprehend all technical sciences, and especially those in which patents are granted. It will be published in three volumes, each of which will be alphabetically arranged in one of the three languages. The society invites the co-operation of technical societies, schools, industrial establishments, trade societies and individuals. Those requesting it will be furnished with special note books for noting down words or phrases, and all are invited to send catalogues, price-lists, books, or other material which might be useful in aiding in the correct definition of terms. Such contributions are to be gratuitous, but the society will bear all expenses pertaining to the preparation and publication of the dictionary. All communications should be addressed to the Editor of the Technolexicon, Dorotheenstrasse 49, Berlin, Germany.

STEAM EXCAVATING AND GRADING MACHINE.

In earthwork excavation for railways, canals, irrigation ditches, roads, and other construction works, extensive use is made of grading machines, fitted with plows or scraper blades. The earth excavated by the plow is delivered upon a traveling belt conveyor at right angles to the path of the machine. The belt is carried on an inclined frame attached to the machine, and from the head of this the dirt is dumped upon the ground or into wagons moving parallel with the machine. These excavating machines are usually drawn by teams of horses, but one of the recent innovations in construction machinery is a steam grader, in which the plowing and conveying apparatus are attached to a traction engine.

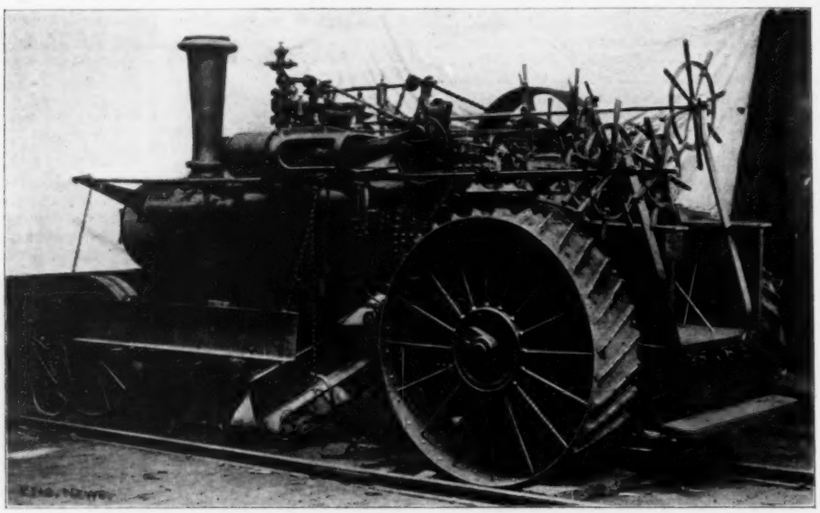

FIG. 1. STEAM GRADING MACHINE (PLOW SIDE).
Bunnell Machinery Co., Chicago, Builders.

The first of these steam graders is shown in the accompanying cuts. In the view of the plowing side of the machine, Fig. 1, it will be seen that the plow is attached to a plow-beam consisting of a steel channel. This beam has an arm on the inner side, which projects under the boiler and is attached by a draft chain to the king-bolt of the pivoted front axle. The beam is suspended at each end by chains from a shaft extending along the boiler, and by this means the beam may be raised or lowered to regulate the depth of cut of the plow, or it may be tilted so as to raise or depress the point of the plow. The front end of the beam has a small "castor," or guide wheel, and a coulter or cutting wheel may also be attached to the beam, running ahead of the plow. The chain shaft is double; its smaller part is solid, and extends the full length of the boiler, and to it is attached the chain at the front end of the plow beam. This is operated by a small hand-wheel on the left of the engineman's platform. The larger shaft is shorter, and is a pipe or sleeve surrounding the solid shaft; this carries the chain of the rear end of the plow beam, and is operated by the larger hand-wheel.

In line with this shaft and sleeve (and hidden by them in Fig. 1) is a solid shaft, to which are attached the chains suspending the lower or receiving end of the belt conveyor, which is shown just behind the plow. This is operated by the third hand-wheel on the left side of the engineman's platform.

The conveyor is made in five sections. One section is under the boiler, as shown in Fig. 1. The four remaining sections are of varying lengths, and extend on the opposite side of the engine, as shown in Fig. 2; these are so joined together that one or more may be removed to shorten the conveyor when desired. The outside sections are pivoted, and the height of the pivot shaft is regulated to correspond with the shorter section by means of chains connected with the lower of the two shafts, shown above the right-hand side of the boiler in Fig. 2. This shaft is operated by a ratchet handle. The elevation of the delivery head of the conveyor is regulated by chains operated by a shaft and hand-wheel, the chains passing over grooved idlers. The chains connected with the pivot shaft and delivery head of the elevator, respectively, are wound upon the two shafts on the right-hand side of the boiler, as shown in Fig. 2. The pivot shaft and delivery head of the conveyor can thus be raised and lowered by the engineman by means of the ratchet handle and hand-wheel.

The driving shaft of the conveyor is operated by a sprocket chain, and power is transmitted from this shaft to the shaft at the head of the conveyor by a link belt and sprocket wheels. The rubber conveyor belt is continuous over both sections of the conveyor frame, and is normally drawn tight, instead of sagging below the frame, as shown in Fig. 2. The material may be discharged from the conveyor to form a bank parallel with the excavation, or it may be delivered into wagons and hauled away for disposal for filling or in other ways.

The plowing and conveying apparatus are carried by a 20-HP. traction engine built by the J. I. Case Threshing Machine Co., of Racine, Wis., fitted with the necessary attachments. The engine has a locomotive boiler mounted on two axles. The forward axle is pivoted, and the engine is steered by this axle by means of chains wound on drums on a lateral shaft operated by a worm gear, the worm being on the end of an inclined shaft on the right side of the engine, this shaft being fitted with a hand-wheel convenient to the engineman. The front wheels are 44 ins. diameter and 10 ins. wide; and the driving wheels are 66 ins. diameter and 20 ins. wide. The wheels have steel rod spokes, and grips or cleats are riveted to the faces of the driving wheels. The wheelbase is 11 ft. 2 ins. The boiler is 2 ft. 5 ins. diameter, with 44 tubes 2 ins. diameter and 7 ft. 6 ins. long. The firebox is 42 × 27 ins., with a height of 37½ ins., and has a cleaning door on the left side. There is a single cylinder 11 × 10 ins., mounted on the front end of the boiler shell, on the left side; this is connected to a crank disk on a shaft across the top of the firebox, from which shaft the driving wheels are operated in the usual way by gearing. The weight of the engine, without the grading and conveying attachments, is about 15,500 lbs.

The several shafts for the plow and conveyor chains are carried in brackets riveted to the boiler and to the back of the engine frame. The speed and direction of the engine, and the positions of the plow and conveyor are all conveniently controlled by the engineman.

These steam grading machines have been invented and patented by Mr. Morton G. Bunnell, President of the Bunnell Machinery Co., Old Colony Building, Chicago, Ill. The first machine was sold to the Wendelken Construction Co., of Dallas, Tex., and used on an extension of the Calvert, Waco & Brazos Valley Ry. (International & Great Northern Ry. system), between Marlin and Waco, Tex. Mr. J. D. Trammell is Chief Engineer of the I. & G. N. Ry. On this contract the soil is heavy, and the plow makes a cut of 6 ins., the material being delivered into dump wagons. The engine travels at a speed of about three miles per hour, and excavates from 1,000 to 1,500 cu. yds. of material per day. The cost is reported to us as about half that of excavating with a grading machine hauled by horses. The experience with this machine has been so satisfactory that another engine was ordered for work on the same contract.

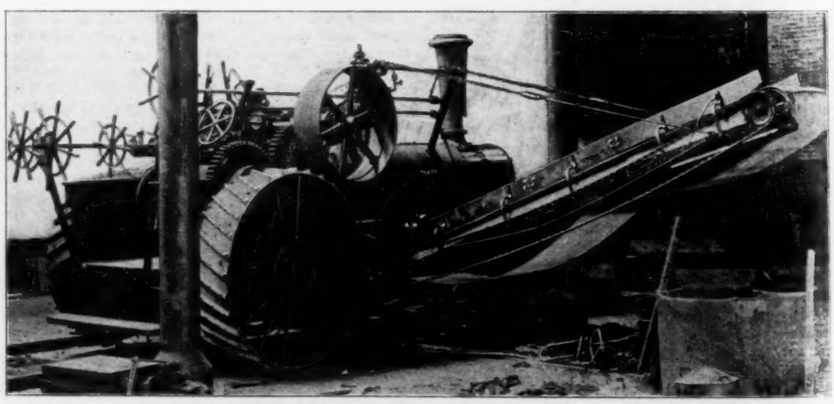

FIG. 2. STEAM GRADING MACHINE (CONVEYOR SIDE).

COMPARISON OF FORMULAS FOR FLOW OF WATER IN CLEAN CAST-IRON PIPES.

By Frank S. Bailey.*

With the aid of the accompanying table, a comparison can be made, within certain limits, of various formulas of the form $V = C D^x S^y$ for the flow of water in clean cast-iron pipes, in which

V = velocity in ft. per sec.;
C = a constant coefficient;
D = diameter of pipe in ft.;
S = sine of slope;
x and y = constant exponents of D and S, respectively.

The velocities derived from Hamilton Smith's table of coefficients, and by the Lampe and the Flamant formulas, are copied from a table found in the recently-published work on "Public Water Supplies" by Turneaure and Russell.

The velocities given by the other formulas have been computed for the same slopes and diameters; a slide rule was used in the work, and in some

*Member of Boston Society of Civil Engineers and assistant in Engineering Department, Massachusetts State Board of Health, Boston, Mass.

cases the figures may not be precisely correct, but they are generally close enough to afford a means of comparing the different formulas.

Assuming that the velocities derived from Smith's coefficients are the proper ones to use as standards of comparison, it will be seen that the Lampé formula (which, if I am not mistaken, is the oldest one of this form) gives better results as a rule, than the Flamant, although the Flamant formula agrees fairly well with the standards. The Foss formula gives too low velocities for the 2 and 6-in. pipes, but gives better results for the diameters above 1 ft. than any of the others.

Mr. Tutton states that in his formula, in the form $V = C\ R^{.66}\ S^{.51}$, C varies from 126 to 158, which values are equivalent to a variation in C of from 50.5 to 63.3 in the form $V = C\ D^{.66}\ S^{.51}$.

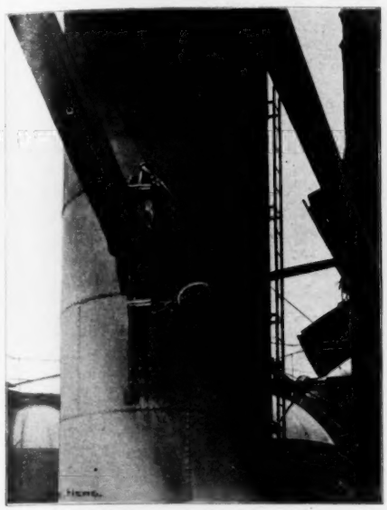

Fig. 1. View Showing Manner of Attaching Derrick Boom to a Wrought-Iron Smokestack.

In the above table, 60 has been assumed as the value of C, as it gives as good results on the whole as would any other constant value. The difficulty with this formula, as compared with the preceding ones, is that it gives results about 10% too high on the low velocities, and a little less than 10% too low on the high ones.

The Hazen and Sullivan formulas are open to the same general objection. In the case of the 2-in. diameter, however, the Sullivan formula gives a velocity 23% too low on the low grade, and 40% too low on the high one.

It has been found by trial that the formula $V = 74\ D^{.7}\ S^{.55}$, which, it will be noted, differs but slightly from the Lampe formula, has certain advantages over the Lampe formula in the diameters of 6 ins. and over, and is nearly as close as the Foss formula in diameters of 12 ins. and over, while it comes considerably nearer to Smith's results in the smaller diameters; in the case of the 2-in. pipe it ranks next to the Lampe and Flamant formulas.

It is impossible to represent accurately the changes in velocity due to changes in the interior surface of pipes by merely changing the coefficient C in formulas of this form and applying the new coefficient to all the sizes, as such a procedure, if a similar amount of incrustation occurred in the interior surfaces of both the large and small pipes and a coefficient was derived to fit the new velocities in the large pipes, would give considerably too high velocities for the small pipes, and vice versa. This is due to the fact that the ratio which the interior surface of a pipe bears to its inside area is much greater in a very small pipe than in a large one, varying inversely with the diameter.

In general it may be said that in order to obtain results consonant with Hamilton Smith's conclusions, the exponent of S in formulas of the above form cannot be less than 0.54, nor more than 0.56. If the exponent of S is less than 0.54 the low velocities, i. e., about 1 ft. per sec., will be too high, and the high velocities, i. e., about 10 ft. per sec., too low, and if the exponent is above 0.56 the effect will be just the reverse.

When the exponent of S is within the above mentioned limits, the exponent of D cannot be less than 0.69, nor more than 0.73, as, if it is less than 0.69, the velocities in the small pipes will be too high, and in the large pipes too low, and if the exponent is more than 0.73 the effect will be reversed.

When the velocities for a 12-in. pipe in formulas of this class are in exact accordance at different grades with the assumed standard, the velocities for the extreme sizes, both large and small, will be approximately from 5 to 10% too low, and it is necessary to derive a variable exponent of D for cases where closer results are desired.

A NOVEL WAY OF CONSTRUCTING A DERRICK.

We illustrate in the accompanying cuts the ingenious adaptation of a wrought iron smokestack to the construction of a temporary derrick at the works of the Lackawanna Iron & Steel Co., of Scranton, Pa. As related by Mr. A. B. Blackinton, of Scranton, who sends us the photographs from which our cuts are engraved, the works of the company named are being torn down preparatory to their removal to Buffalo, N. Y. In performing a certain portion of the work of destruction a temporary derrick was necessary, and Mr. Arthur Lee, Superintendent of Blast Furnaces of the company, devised the arrangement shown, which consists in attaching a suitable boom to a wrought-iron smokestack as a mast. A 60-ft. boom was attached to the stack at a point about 100 ft. from its top by means of a cast-iron step bolted to the shell, as shown by Fig. 1. The step, as will be seen, provides for both horizontal and vertical movement of the boom, which is supported at the end by a wire rope guy running to the top of the stack, as shown by Fig. 2.

DIAGRAMS FOR CALCULATING THE SAFE LOAD ON CAST-IRON COLUMNS ACCORDING TO THE NEW YORK BUILDING CODE.

By A. Samuel Berquist, C. E.*

The accompanying diagram shows the safe load on cast-iron columns, calculated according to the New York Building Code of Oct. 10, 1899. The diagram gives also the radius of gyration and sectional area for all round columns from 20 ins. to 5 ins. in diameter, the latter size being the minimum diameter allowed. By a simple multiplication it gives also the radius of gyration and area of a square column of the same dimensions as a round one; in fact, it answers at a glance all the questions that the designer wishes to know in computing cast-iron columns. The use of the diagram may be perhaps most readily understood by working out an example:

Suppose we wish to know the safe load on a cast-iron column 16 ins. outside diameter and 12 ins. inside, i. e., 2 ins. of metal and 17 ft. 6 ins. long. At the top of the diagram, Fig. 1, are found the inside diameters from 20 ins. to 4 ins. Follow the vertical marked 16 ins. diameter down, passing two curves, the third curve commencing at 15.9 ins. diameter and sloping downward to the left represents the 16-in. outside diameter column. Follow this curve to the left until it intersects the vertical, reading at the top 12 ins., this gives the radius of gyration in inches at the right, the intersection is at 5. From 5 on the side follow the straight diagonal line downwards till it intersects the heavy horizontal line reading in the center of the diagram 17 ft. 6 ins., we find then at the top of the lower diagram the unit value per square inch, 10,050 lbs. For the area of the given column, follow the 16-in. diameter vertical from the top of the diagram to the foot of the upper one. There is found a curve slanting upward to the left, which gives the area for various inside diameters. Following this curve till it intersects the 12 ins. inside diameter vertical, the intersection is found at a horizontal which at the left hand side reads 88 sq. ins. Remembering that the unit value per square inch was 10,050 lbs., we follow this vertical on the lower diagram till it intersects the horizontal reading on the right 8.8 sq. ins. This intersection takes place a little below a curve, which followed to the left, reads 87,400 lbs. As the difference between two consecutive curves is 4,600 lbs., we interpolate for the distance of the intersection below the curve, say 1,500 lbs. Adding 1,500 lbs. to 87,400 lbs. and multiplying by ten (as we read for 8.8 sq. ins. instead of 88 sq. ins.), we have 889,000 lbs. as the total load on the given column.

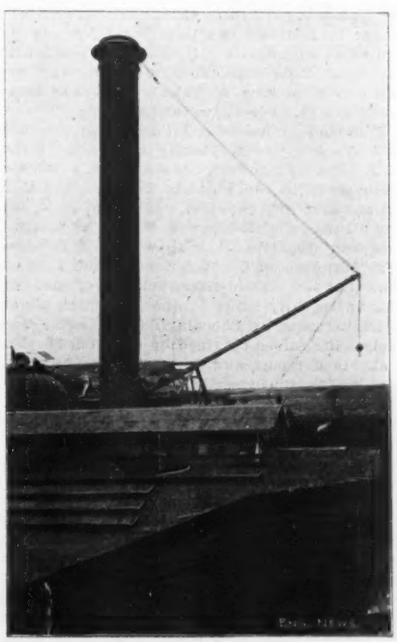

Fig. 2. View Showing Novel Method of Constructing a Derrick.

Performing the various calculations and comparing the results of the calculation with the results found by the diagram, we have:

By diagram:		By calculation:	
Rad. of gyration...	5	Rad. of gyration...	5
Area.....	88	Area	87.97
Unit value.....	10,050	Unit value	10,040
Total load.....	889,000	Total load	883,219

The difference is 0.65%. By close inspection it is easily seen that the value 10,050 is too high, the radial line cutting the 17 ft. 6 ins. length to the right of said value. A little experience makes it possible to read the diagram very closely indeed.

*108 Wilson St., Brooklyn, N. Y.

Computed Velocities in Feet per Second of Flow of Water in Clean Cast-Iron Pipe, in Accordance with Various Formulas.*

		Diameters														
		2 ins.			6 ins.			12 ins.			36 ins.			60 ins.		
Slope		.004	.05	20	.001	.01	.1	.0005	.005	.025	.0001	.001	.01	.00005	.0005	.005
Smith		1.07	4.54	9.68	1.00	3.67	12.80	1.08	3.96	9.56	1.01	3.57	12.60	1.01	3.51	12.50
Lampé	$77.68\ D^{.694}\ S^{.555}$	1.05	4.25	9.17	1.04	3.73	13.38	1.14	4.11	10.03	1.00	3.60	12.92	0.97	3.49	12.54
Flamant	$83.68\ D^{\frac{5}{8}}\ S^{\frac{5}{8}}$	1.02	4.34	9.59	1.02	3.80	14.13	1.12	4.18	10.51	0.98	3.66	13.64	0.95	3.55	13.22
Foss	$69.61\ D^{\frac{11}{16}}\ S^{\frac{11}{16}}$	0.93	3.69	7.86	0.97	3.41	11.98	1.10	3.87	9.31	1.02	3.58	12.57	1.01	3.56	12.47
Tutton	$60.0\ D^{.66}\ S^{.51}$	1.10	3.99	8.09	1.12	3.62	11.72	1.24	4.02	9.15	1.13	3.66	11.85	1.12	3.59	11.64
Hazen	$54.66\ D^{\frac{2}{3}}\ S^{\frac{1}{2}}$	1.13	4.00	8.00	1.12	3.55	11.19	1.22	3.86	8.65	1.08	3.44	10.84	1.05	3.34	10.57
Sullivan	$50.0\ D^{\frac{2}{3}}\ S^{\frac{1}{2}}$	0.82	2.91	5.83	0.94	2.97	9.39	1.12	3.54	7.90	1.14	3.60	11.40	1.18	3.74	11.81
(Trial)	$74.0\ D^{.7}\ S^{.52}$	1.01	4.06	8.70	1.02	3.62	12.84	1.13	4.01	9.72	1.01	3.57	12.68	0.99	3.49	12.38

*Of the type, $V = C\ D^{x}\ S^{y}$.

For another example, suppose it is required to design a column to carry 600,000 lbs. with a unit load of 10,000 lbs. per sq. in. Looking over the lower diagram, we see that 59,800 lbs. is the nearest value tabulated. This curve intersects the vertical representing 10,000 lbs. at about 6 sq. ins. Reading the area to the right, the requisite area is, therefore, 60 sq. ins. Now if the column is 14 ft. 7 ins. long (every division horizontally on the upper diagram represents 7 ins.), five lines above 11 ft. 8 ins., i. e., 11 ft. 8 ins. plus 2 ft. 11 ins., we see at once that the radius of gyration must be at least 4. Following this horizontal line to the left, the column must be at least 12 ins. in diameter, all other curves being below the 4-in. radius line. As the 12-in. curve is dotted at the intersection, we go to the next curve above which is the 14 ins. diameter curve.

The reason for the 12-in. curve, as well as all the rest of the curves being dotted for some distance from the beginning, is that the law requires all columns to have a thickness of at least one-twelfth of the diameter, except in case that would give a thickness of less than ¾-in., when the thickness must be made at least that amount, see equation VIII., Fig. 2. However, as it is a convenience to obtain radius of gyration for other round sections (steel columns, etc.) it has been retained in the chart.

The 14-in. diameter column has the requisite radius of gyration and a little to spare. Now for the thickness we require 60 sq. ins. Follow the 14-in. inside diameter vertical to the lower part of the upper chart, then follow the curve slanting upwards to the left until it intersects the heavy horizontal line reading 60 sq. ins. at the left, the intersection is at about 10.9 ins. diameter. The required column is, therefore, 14 ins. outside diameter and 10⅞ ins. inside diameter. Since the radius of gyration of this column is a little more than 4 ins., we are entitled to figure on a somewhat higher unit value than 10,000 lbs. per sq. in., or we may go to a little smaller outside diameter. All these things can be seen at a glance; in fact, we can interpolate for any desired value with only a pair of dividers and a little judgment. This diagram shows in a very concrete way what it would take a number of tables to express in a decidedly abstract way.

All the equations used in designing this diagram are collected for handy reference. Equation I. (Fig. 2) has been deduced from a table of values given in the Building Code, as the Code does not give any equation. However, as it satisfies all the tabulated values, it may be accepted as correct. Equation II. is from Prof. J. B. Johnson's "Materials of Construction." Prof. Johnson shows that test on full-size specimens of cast-iron columns, recently made by the New York Building Department, at Phoenixville, Pa., agree very closely with values obtained by equation II. For an extended report and discussion on the above tests, see Engineering News, January to July, 1898.

It may be of interest to note that the factor of safety adopted by the Building Code is about 3 as compared with Prof. Johnson's breaking load formula. Equations III. and IV. are self explanatory. Equations V. and VI. make this diagram of double value, as they enable us to find the values of a square column simply by multiplying the diagram values of a round column by 1.1547 for the radius of gyration and by 1.27 for the area; or, in other words, when a round and a square column have the same dimensions, the square column has 15% greater radius of gyration, but 27% greater area, and is consequently less economical.

Equation VII. states a desideratum from the Code and that point is marked with a circle on the diagram. It expresses also the limiting length of a column. Equation VIII. for the thickness has already been referred to. In addition to that stipulation, the Code requires that

> whenever the core of a cast-iron column has shifted more than one-fourth of the thickness of the shell the strength shall be computed, assuming the thickness of metal all around to be equal to the thinnest part.

This paragraph leads me to suggest a shape of column, which I adopted several years ago, while engineer for the American Sugar Refining Co., and have used with satisfactory results. Referring to Fig. 2 it will be seen that the section is of the type of a steel column with 4 angles and a web plate. With this shape it is possible to detect almost all imperfections. For connections to beams it is very well adapted and for extra heavy loads an extra rib can be added, as shown in dotted lines; the ribs should, of course, be tied together at intervals with a bracket or shelf. The disadvantages of the column are, of course, that the radius of gyration is small compared to the section. While I much prefer a steel to a cast-iron column, there are cases when it is necessary to use the latter; and if we must have them I prefer a section that can be thoroughly inspected, even if it costs a little more.

Should any of the readers of Engineering News wish a blue print of this diagram on a larger scale (about 20×24 ins.), it can be had for 35 cts. by addressing the author.

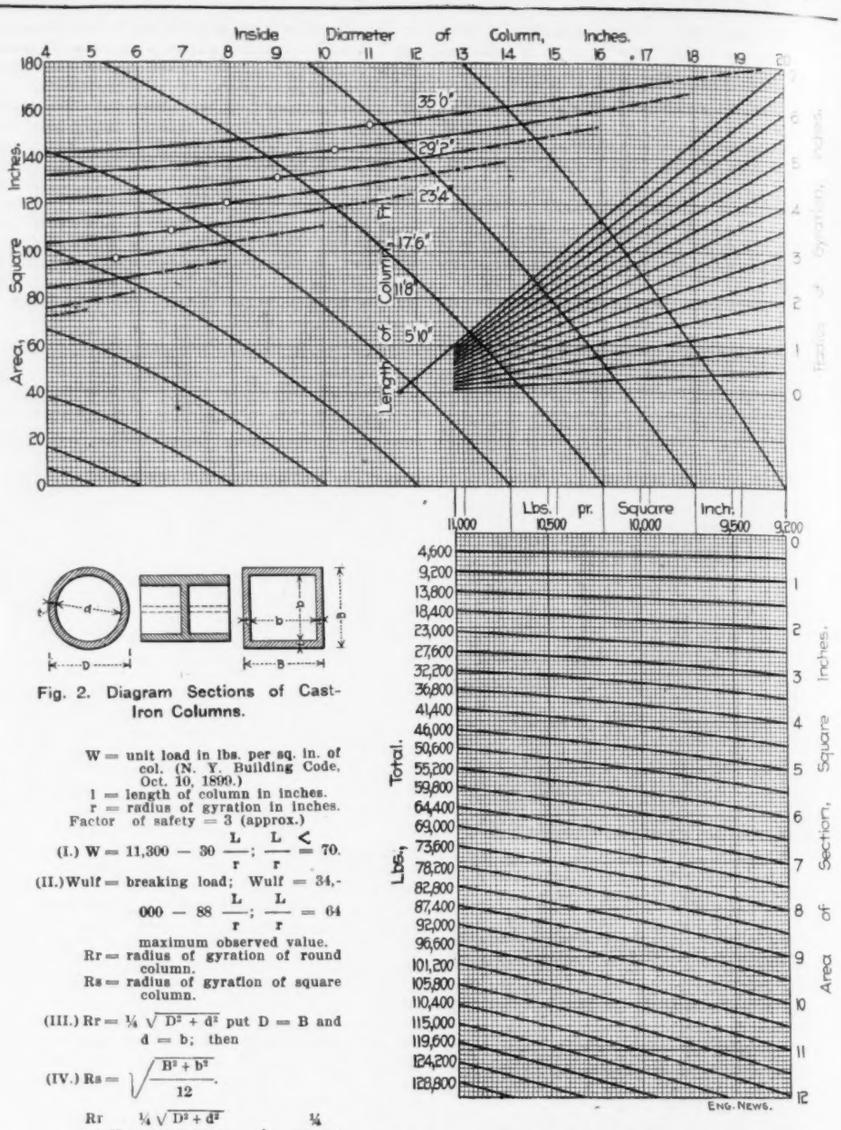

FIG. 1. DIAGRAM FOR CALCULATING THE SAFE LOAD ON CAST-IRON COLUMNS, ACCORDING TO THE NEW YORK BUILDING CODE.

Fig. 2. Diagram Sections of Cast-Iron Columns.

W = unit load in lbs. per sq. in. of col. (N. Y. Building Code, Oct. 10, 1899.)
l = length of column in inches.
r = radius of gyration in inches.
Factor of safety = 3 (approx.)

(I.) $W = 11{,}300 - 30\frac{L}{r}; \quad \frac{L}{r} < 70.$

(II.) Wulf = breaking load; $Wulf = 34{,}000 - 88\frac{L}{r}; \quad \frac{L}{r} = 64$ maximum observed value.

Rr = radius of gyration of round column.
Rs = radius of gyration of square column.

(III.) $Rr = \frac{1}{4}\sqrt{D^2 + d^2}$ put D = B and d = b; then

(IV.) $Rs = \sqrt{\frac{B^2 + b^2}{12}}.$

$$\frac{Rr}{Rs} = \frac{\frac{1}{4}\sqrt{D^2 + d^2}}{\sqrt{\frac{D^2 + d^2}{12}}}, \quad \therefore \quad \frac{\frac{1}{4}}{\sqrt{\frac{1}{12}}} = \frac{\sqrt{12}}{4} = 0.866025$$

$\left(\frac{21}{24}\right.$ approximate.$\left.\right)$

(V.) $Rs = \frac{Rr}{0.866025} = \frac{Rr}{\cos 30°} = Rr \sec 30° = Rr\ 1.1547.$

Ad = area of round column $= \frac{\pi}{4}(D^2 - d^2)$; as before put D = B, and

As = area of square column $B^2 - b^2$; d = b; then

$$\frac{Ad}{As} = \frac{\pi}{4} = 0.78539$$

$\left(\frac{25}{32}\right.$ approximate.$\left.\right)$

(VI.) As = Ad 1.27.

(VII.) L should not exceed 20 D"; $\frac{L}{r}$ must not exceed 70.

(VIII.) $t = \frac{D}{12}$, but t must not be less than ¾".

NOTES FROM THE ENGINEERING SCHOOLS.

ARMOUR INSTITUTE OF TECHNOLOGY.—This institution has issued its Year Book for 1901-1902, giving particulars of the courses in civil, mechanical, electrical and chemical engineering, and architecture. There are also lists of the engineering graduates of each year, beginning with 1897, and giving the present position of each graduate. The publication is an octavo book of 110 pages. It is accompanied by two pamphlets, reprints of addresses by Victor C. Alderson, Dean of the Institute. One of these is on "The Engineer Rule of the Twentieth Century," and the other on "Ethics of the Engineering Profession."

THE REDRIDGE DAM.

(With two-page plate.)

The extensive works being carried out by the Atlantic Mining Co. and the Baltic Mining Co., under the direction of their agent, Mr. Frank McM. Stanton, M. Am. Soc. C. E., for the development of their properties in the copper region of northern Michigan, include the construction of a high dam on the Salmon Trout River, at Redridge, Mich., to furnish water to the stamp mills. The site is only a few hundred feet from Lake Superior, and the crest of the dam will be about 84 ft. above the normal lake level.

The Redridge dam is unique in being a gravity dam of combined concrete and steel construction, and in fact it is the first of its kind. Upon the concrete base is a steel superstructure consisting of a series of bents or A-frames carrying steel face-plates, and in this respect the dam is similar to the steel dam built for the Atchison, Topeka & Santa Fe Ry., at Ash Fork, Ariz. (under the Bainbridge patents), which was described and illustrated in our issue of May 12, 1898. The most important difference in the design of the two dams lies in the use of a concrete base in the Redridge dam. In the Ash Fork dam, concrete is used merely to effect a watertight joint at the heel, the steel structure being anchored directly to the rock in a canyon, and relying upon its anchorage to resist overturning or sliding. In the Redridge dam, however, the natural formation was not favorable to such a construction, and it was decided to use a concrete base of such dimensions as to constitute a gravity dam. To this base the steel structure is anchored. The proportions are such that at any section of the dam the resultant of all pressures (when the water is level with the crest of the dam) falls within the middle third of the concrete base. The calculations were made to include sufficient friction to provide against sliding (coefficient of friction, 0.69), but there is a large additional margin of safety against sliding movement through the fact that the concrete base is built in a trench 2 to 4 ft. deep in the rock.

The dam is 1,006 ft. long, and the length of the steel portion is 464 ft. between the abutments. The maximum height is 74 ft. At either end of the steel dam are earth embankments with masonry core walls, bringing the total length of the dam to the figure above stated.

The reservoir formed by the dam will have an area of 150 acres, and an available storage capacity of 600,000,000 gallons, the intake pipes being placed 20 ft. below the crest. The water will be carried by steel conduits to the stamp mills of the Atlantic mine, 1,800 ft. distant, and the Baltic mine 2,200 ft., the estimated daily consumption being about 25,500,000 gallons. A wasteway is provided for flood water, no water being allowed to pass over the crest of the dam.

Along the rear of the dam extends a steel trestle for a railway track. The map, Fig. 1, shows the position of the dam, wasteway, trestle, etc., in relation to the flumes and the stamp mills.

FOUNDATIONS, ETC.—The dam is founded on bed rock for its entire length, except under part of one core-wall, where an impervious clay was encountered. The rock is hard, strong and generally free from fissures; but it has been more or less eroded at a point a short distance above the present dam site, where a wooden dam with crest some 20 ft. lower than the present dam has stood for many years.

To guard against the possibility of water working its way from these eroded holes between the rock strata, and finally underneath the new dam, the novel plan was devised of making an impervious cut-off dam in the natural rock above the site of the new dam. This cut-off dam was made by making a line of drill-holes in the rock clear across the canyon and forcing them full of cement grout. This line of holes was made about 20 ft. above the upstream face of the dam, and parallel with it. The holes were made 2 ins. diameter, 10 ft. deep, and spaced 7 ins. apart. Grout was forced into these holes under an air pressure of 90 lbs. per sq. in., and there was good evidence that the grout did fill and seal openings in the rock adjacent to the holes. After this work was done, the rock floor between the dam and the line of holes will be cleaned and covered with a concrete pavement, and that in turn by a puddle bank.

CONCRETE BASE.—The concrete base was at first planned as of approximately rectangular section, but in the adopted section a much better distribution of the material has been effected, the height being very much greater at the upstream face than at the toe, as shown by the strain diagrams in Fig. 4. The sealing wall 4 ft. wide and 5 ft. deep, is carried below the base of the dam. The dimensions of the section vary at different parts of the dam, according to the depth, the variations in both width and depth being made by offsets, as shown by the general plan and elevation, Fig. 3. At each end is a concrete abutment, with concrete core-wall extending back into the hill side, the core-walls being supported by earth embankments. The abutments serve for both the dam and the railway structure. Beyond the end bent of the steel-work, and forming an extension of the steel face, extends a plate about 4 ft. wide, with a steel angle riveted along the outer edge. The plate and the end bent are embedded in the abutment, and thus firmly anchored. The abutment is bonded to the core-wall by steel rails put together in pairs, with 2-ft. anchor rods between them. These are embedded horizontally in the concrete.

The concrete is composed of 1 part Atlas Portland cement, 3 parts stamp sand (the tailings from the stamp mills), and 5 parts of broken trap rock. For column bases and other parts where a denser and richer mixture is required, the proportions are 1 part cement, 1 part stamp sand, 1 part bank sand, and 4 parts stone. The materials were brought by rail to the site in the four-wheel drop-bottom dump cars used for hauling ore from the mine to the mill, and were discharged into bins under a temporary trestle several feet above the level of the mixing platform. The concrete was mixed in gravity mixers made by the Contractors' Plant Co., of Boston (Eng. News, Jan. 5, 1899). The mixer consists of a hopper and an inclined trough or chute, fitted with deflecting blades and pins. The measured quantity of stone is spread on the platform and covered with the proper quantities of cement and sand. Then the materials are shoveled, without further mixing, into the hopper, the mixed concrete being discharged at the bottom into wheelbarrows. A man at the bottom controls the water supply and the discharge gate. In some cases it was necessary to lengthen the chute, and the extension was fitted with pins to prevent the mixed materials from again separating.

Some measurements of concrete in place indicated a weight of 165 lbs. per cu. ft., and tests of 6-in. cubes have shown a crushing strength of 1,800 lbs. per sq. in. at 26 days. The permissible loading under bearing plates is limited to 200 lbs. per sq. in., and at these places also a special concrete is used. On the main body of the dam the pressure induced by the water is very much less than this. In the calculations, the weight of the concrete was assumed at 145 lbs. per cu. ft., so that the actual structure has an excess of weight. The concrete is mixed comparatively dry, with only enough water to flush to the surface during ramming. There are about 8,000 cu. yds. of concrete in the main dam, and about 2,000 cu. yds. in the abutments and core-walls. Fig. 2 is a view of the work under construction, showing the lower part of the concrete, with anchor rods in position. The train on the temporary trestle dumps the materials for the concrete into bins. The concrete is roughly mixed on the upper platform and discharged by the gravity mixers into wheelbarrows on the lower platform. At the left is the flume carrying the overflow from the old dam.

The profile of the upper part of the concrete is inclined, to conform to the slope of the steel facing, the beams of the steel bents being embedded in the concrete, as shown. The concrete extends up behind the steel facing, and forms a bench where the curved steel face-plates end, this bench being covered by an inclined diaphragm plate. To ensure close contact of the steel and concrete, holes are tapped in the diaphragm plate, to which nozzles for grouting pipes can be screwed, the grout being forced in behind the steel under a pressure of about 90 lbs. The concrete was not built to its full height at first, but only far enough to receive the steel-work. Upon this the separate bases for the steel columns were built in forms, in such a manner that these will be embedded in the upper mass of concrete. To ensure the proper position of the anchor bolts, the forms for the column bases had frames attached so that when the forms were in position the ends of the rods rested upon the frames in the positions they occupy in the finished work.

STEEL SUPERSTRUCTURE.—The steel portion of the dam is 464 ft. long on the crest, between the concrete abutments, and consists of a series of steel bents or A-frames, 8 ft. apart, to which is riveted a facing of steel plates. These bents are braced together in sets of three, as shown by the elevation in Fig. 3. Typical cross-sections at the highest and lowest portions are shown in Fig. 4. The face is inclined at an angle of 55° 58′, while the apex angle between the face and the columns is 56° 10′. In each bent, all the members are in compression, with the exception of the members parallel with the face, and also, of course, excepting the anchor rods. The face member is an I-beam (15-in. in the smaller bents and 24-in. in the others); all the other members are built-up of angles, Z-bars and plates, as shown in Fig. 4. All the material is of mild steel. Riveted between the bents are ⅜-in. curved face-plates, concave to the water, 7 ft. 5½ ins. wide over the chord, and having on each side a flat strip 5⅞ ins. wide, which is riveted to the flange of the I-beam. The radius of the curve is 7 ft. 5 7-16 ins. The plates are 16 ft. high. This face construction is covered by the patents of Mr. F. H. Bainbridge. Below the bottom course of curved plates is a course of flat plates, and the open space thus left in each bent is closed by a segmental inclined diaphragm. The vertical joints are double-riveted, the face-plates lapping each other on the I-beams. The horizontal joints are single-riveted, with welt strips on the back. The rivets are ¾-in. diameter, 2½ ins. pitch.

One of the peculiar features of the construction is that below the ⅜-in. face-plating of the steel portion, is a facing of flat 3-16-in. steel plates covering the concrete base. At the bottom this plate is let into a trench sealed with a rich cement mortar. This plating is in courses, 3 ft. 6 ins. high, put together with ⅜-in. rivets, and stiffened by vertical angle irons at the back, 4 ft. apart. The crest of the dam is finished with a facia plate cut to fit the curved face-plates. Fig. 5 is a view of a part of the completed steel work, taken July 9, after a heavy rainstorm, the water being about 25 ft. deep in the channel and 1 ft. deep over the concrete. This view plainly shows the curved face plates, the steel frame, and the steel trestle behind the dam. The four bottom discharge pipes are visible at the surface of the water. At the extreme right may be seen a part of the steel facing of the concrete. The steel derrick used in the erection of the structure is partly shown in this view, the post being on the trestle, with one rear brace and one side brace, the latter carried on a frame running on a temporary rail bolted to the face of the dam. It may be noted here that all the riveting and calking was done by the use of long-stroke portable pneumatic hammers.

Before and after erection, the ⅜-in. face-plates were given one coat of Edward Smith & Co.'s durable metal coating, while the 3-16-in. facing was given two coats after erection. The rear of all the plates to be in contact with the concrete was first cleaned of all dirt, scale, and rust; then washed with acidulated water and rinsed with lime water to neutralize the acid. This left the metal clean and in good condition to form a bond with the concrete. All the other parts of the steel-work are painted with graphite paint.

CONDUITS AND DISCHARGE PIPES.—Passing through the concrete base of the dam, 20 ft. below the crest, are three 24-in. intakes, with cast-iron mouthpieces. These are fitted with screens and have bronze sluice gates sliding in guides, and operated from the top of the dam by hand-wheels and screws. They are also controlled by 24-in. gate valves, directly accessible in valve pits formed in the concrete. On the west side the intake will connect with a 38-in. riveted steel pipe

leading to the Baltic mill, 2,200 ft. distant. For the purpose of regulating the level of the reservoir four 24-in. discharge pipes are built into the concrete base, as shown in Fig. 4. Like the intakes, these are fitted with a double system of control: The mouth of each pipe has a sliding gate, with stems carried by brackets riveted to the face-plates and operated by hand-wheels and screws above the crest; each pipe has also a 24-in. gate valve, set in a valve pit formed in the concrete, so that the valves are readily accessible for repairs.

WASTEWAY AND SPILLWAY.—As already stated, the dam is not intended to act as a weir, but through the hill on the west of the dam an excavation has been made for a wasteway. The location of this is shown in Fig. 1, and the construction is shown in Fig. 6. The mouth of this is 30 ft. long, tapering from 50 ft. to 30 ft. in width, and having a concrete head wall whose sill is 6 ft. below the level of the crest of the dam. Upon this will be steel standards carrying flash-boards, which will ordinarily retain the water at full level, but can be removed in time of flood.

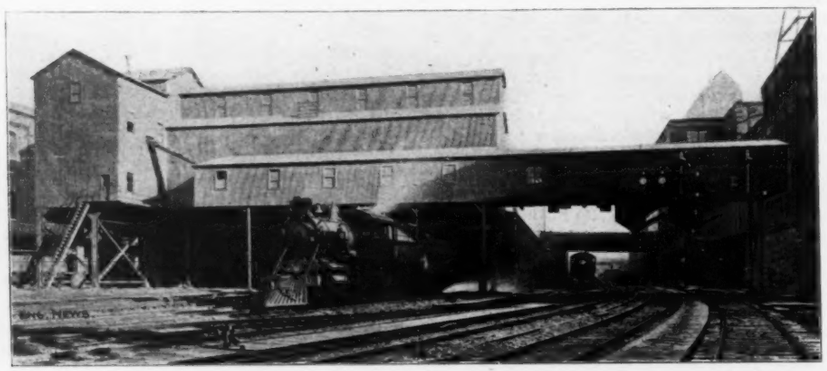

FIG. 1. GENERAL VIEW OF LOCOMOTIVE COAL AND ASHES HANDLING PLANT; PHILADELPHIA & READING R. R., PHILADELPHIA, PA.
Link Belt Engineering Co., Philadelphia, Pa., Builders.

From the concrete wall extends a timber flume 30 ft. wide and 4 ft. deep, for a length of 400 ft., discharging over the bank of the river. The combined capacity of the flume and the discharge pipes is more than sufficient to dispose of the heaviest floods yet known.

A peculiar feature of the construction of this flume is the provision made for renewing the wearing surface. Longitudinal cedar sills are embedded in the sandy soil, and covered with a flooring of 3-in. pine planks on cross joists. The sides are of similar planks, spiked to stanchions supported by braces, as shown by the cross-section in Fig. 6. Upon this planking are laid three thicknesses of tarred felt, the sheets extending unbroken from the top of one side to the top of the other side, and breaking joints. This is covered with two courses of 1-in. pine sheathing, the outer one of which can be renewed or repaired without disturbing the water-proofing construction. Triangular timbers are laid in the corners.

STEEL TRESTLE.—The mining company's railway branch to the Baltic mine will cross the gorge on a steel trestle just below the dam, as shown in Figs. 1 and 3. Most of the trestle bents rest upon the concrete base of the dam, but a few have independent concrete pedestals. The maximum span is 72 ft. The two lines of plate girders are 7 ft. apart. Ties of extra length will carry a footwalk close to the crest of the dam, giving ready access to the platforms from which the sluice gates of the outlet and discharge pipes are operated. The footwalk will have two hand rails. The trestle is 468 ft. long, and has the same abutments as the dam. Concrete abutments will also carry a steel span over the wasteway. The trestle is designed for the live load of Class E 35 of Cooper's specifications. All this steel-work is painted with a graphite paint.

ENGINEERS AND CONTRACTORS.—The entire dam and its appurtenances are being constructed under the direction of Mr. Foster Crowell, M. Am. Soc. C. E., of New York, who is Consulting Engineer for the hydraulic works of the mining companies, and all plans and specifications were prepared or approved by him. Absence of durable building stone in this region, and the possession by the Atlantic Mining Co. of very excellent rock and sand for concrete, led to the selection of the latter materials in connection with steel for the main dam and concrete core-walls with earth embankments for the wings. So far as the steel and concrete combination is concerned, the propostion to adopt a dam of this type originated with Mr. J. F. Jackson, Assoc. M. Am. Soc. C. E., of Houghton, Mich., who is Resident Engineer for the Wisconsin Bridge & Iron Co. It was evident, as stated above, that the dam could not be anchored directly into rock, as had been done at the Ash Fork dam. The idea of combining a concrete base and a steel superstructure so as to form a gravity dam then occurred to Mr. Jackson, who proceeded to work out forms and sections for heights varying from 28 ft. to 74 ft., as included in the main portion of the dam. After the approval of the plans by Mr. Crowell, a contract for the steel superstructure was let to the Wisconsin Bridge & Iron Co., of Milwaukee, Wis. (which firm also built the Ash Fork dam). A separate contract for concrete work was let to Prendergast & Clarkson, of Chicago. The excavation and other portions of the work were done directly by the Atlantic Mining Co.'s force, under the direction of Mr. F. G. Coggin, Jr., Superintendent of the stamp mills, who is also in general charge of the whole work.

Work was begun on the excavation in June, 1900, but was greatly delayed by the excessive and unusual rains of last summer and autumn. It was recommenced in May of the present year. The steel-work is now nearing completion, and it is expected that the dam will be ready for service by September.

PACKING GOODS FOR EXPORT.

While the export of American manufactures is growing at a phenomenal rate, many of our manufacturers are slow to appreciate the importance of the proper packing of goods so shipped, and complaints of bad packing by American exporters are altogether too frequent. In our country, with rapid transportation, comparatively shorter distances and different methods of handling goods in transit, our practice may be sufficient. In sending these goods across the seas, however, to consumers accustomed to different and more elaborate and careful methods of shipping, our exporters must change their practice and more nearly conform to the demands of our foreign consumers. Good and otherwise acceptable goods may be ruined and prospective business summarily checked by bad packing; and this is an important factor in the extension of our foreign trade which our manufacturers cannot affort to overlook. In this connection, the following information, by Mr. Charles Neuer, U. S. Consular Agent at Gera, will be interesting to American exporters:

In most European countries, great attention is given to good packing, as no matter how excellent the goods, they are sure to lose in value if badly put up. For dress goods, which form the bulk of the exportations from this district, strong boxes are made to hold a certain number of pieces. The goods are then packed in firmly, each piece being wrapped in strong glazed paper. The box itself is lined with oiled paper, so as to preserve its contents from dampness, and strapped with iron bands. Great stress is laid on durability and neatness, and old boxes are never used. For shipment to Africa and Australia, the pieces are wrapped in oiled paper and the cases lined with tin. The tin is carefully soldered to make it weather-tight. Merchandise packed in this manner may be sent to the most distant countries without damage. For some manufacturers, the covers of the boxes are fastened with screws to prevent theft. Nothing is neglected to insure arrival in good condition, and the neat and substantial way in which the goods are packed cannot fail to make a favorable impression upon the purchaser.

In making shipments to Europe, our exporters should wrap their goods so as to exclude moisture, and pack them in strong wooden boxes. The boxes should be nailed with wire nails and strapped with iron bands. Goods in bales should be securely wrapped in oil cloth lined with paper, to prevent its adhering to the contents, and covered with strong canvas. The bales should then be pressed and hooped with iron. Economy of space is an important consideration. Special care should be taken by our manufacturers to wrap articles of cast iron so as to avoid shifting. On account of careless packing, goods of this class frequently arrive here either broken or rusty. The bottoms of the cases should be well fastened. Care is also necessary in driving nails, which are often found to have penetrated and damaged the contents of the boxes. Considering the distance the goods are transported and the amount of handling they receive, the packing is often sadly inadequate. As an illustration of this, a number of large American stoves were ordered by a local merchant, and upon their arrival some of them were badly broken and many of the smaller attachments—such as screws, knobs, etc.—missing. The stoves were packed in crates weighing over 400 lbs., which made careful handling impossible. The attachments, including the heavy lids, were put in the ovens loose, and shifted noisily about whenever the crates were moved. Of course, all orders were canceled.

Regarding our preserved fruits, I have been told again and again that they would sell much better if put up in glass bottles, even if the prices were a little higher. There is a great deal of prejudice against tinned goods, as it is believed they might be poisonous. Boxes of canned fruits should be banded with iron. The pine boxes used are not equal to the treatment to which they are subjected, and sometimes arrive in a poor condition.

Another American article which lacks the necessary care in packing is resin. The excuse that this article is very cheap, and for that reason does not warrant better packing, is not valid. Cheap packing in the long run is the dearest, owing to the losses sustained, while care in this respect will do much to enhance the value of an article in the eye of the foreign purchaser.

I could name a number of other articles with the packing of which fault is found, but it is unnecessary. Suffice it to say that good packing of all kinds of American merchandise will tend to materially increase our export trade. It is conceded that our manufactures are superior to all others, and we only need to correct these minor faults to render our position in the mercantile world unassailable.

LOCOMOTIVE COAL AND ASHES HANDLING PLANT, PHILADELPHIA & READING RY., PHILADELPHIA, PA.

The statement was recently made by a high official of the motive power department of one of the large trunk line railways that the cost of handling coal at the company's coaling stations ranged from 1.4 cts. per ton at the most economical plants to 41 cts. per ton at the antiquated and most expensive plants. This statement illustrates excellently the important part which the locomotive coaling station plays in the economy of the railway motive power department. The same discussion which brought out this statement respecting the relative cost of handling coal at modern and at antiquated plants also indicated a decided preference for the form of coaling station consisting of an inclined trestle approach leading to elevated pockets, with a track on each side, wherever such construction was practicable. It was pointed out, however, that, in crowded city yards and other places where space was limited and land very expensive, it was practically impossible to instal an inclined trestle track, and resort had to be made to some form of mechanical plant occupying less space. During recent years a number of such mechanical locomotive coaling plants have been built by the eastern railways. One of the latest and largest of these is illustrated in the accompanying engravings. This plant was built for the Philadelphia & Reading R. R., and is located in the Pennsylvania Ave. Subway in Philadelphia. It is designed for handling both coal and ashes and has a storage capacity for 1,000 tons of coal and 40 tons of ashes. The machinery will handle 120 tons of coal per hour, or two tons per minute; the ash-handling machinery having a capacity of 20 tons per hour.

As shown by the half-tone view, Fig. 1, the main storage pocket spans eight tracks; from seven of these locomotives can receive coal and discharge their ashes simultaneously, while on the

eighth cinders are being transferred from the ashes pocket to cars. In addition to the seven terminal tracks a coaling bridge extends over four running tracks to which coal is delivered by hand-cars moving on their own system of rails and turntables, receiving the coal from the pockets, as shown by Fig. 2. Thus it is possible to supply eleven locomotives with coal at one time, while seven of them are also discharging ashes into the link-belt open-top carrier. The ashes as dumped from the locomotives are fed to the buckets of this carrier by automatic gates so arranged that the ashes feed absolutely into the pockets and cannot run or spill over the sides. This carrier is equipped with self-oiling devices to reduce to a minimum the power required to operate the same. The rollers are chamber-cored, and means are provided to renew automatically the supply of oil while in operation.

The coal is dumped from drop-bottom cars, passes through the steel track hopper onto an apron-conveyor which affords an even delivery to the boot and thereby prevents choking and crushing. The elevator is of the gravity discharge type. It is composed of large-capacity V-shaped pockets centrally-hung and rigidly attached to two strands of chain; in the act of passing through the foot of the elevator or boot, they scrape up their loads and elevate the same to the top of the pocket and then convey it along a short, horizontal run, pushing the coal before them and delivering it to the horizontal distributing conveyor.

The interesting feature of this horizontal distributing conveyor is its flights, which are prevented from coming in contact with the bottom or sides of the trough by smooth-sliding bearing blocks attached to their ends. This construction eliminates the noise characteristic of most scraping conveyors and prolongs the life of the flights and of the trough. These flights are attached to a link-belt monobar chain constructed of 1-in. bolts and 24-in. pitch, and link-belt equalizing gears are employed to do the driving, thus overcoming the jerky pulsating motion inherent to all chain and wheel mechanisms, especially where the chain has a long pitch. The trough is provided with discharge gates at proper intervals operated by rack and pinion. These can be opened and closed while the conveyor is in operation.

The illustrations show clearly the construction and operation of the plant, which was designed and constructed by the Link-Belt Engineering Co., of Philadelphia, Pa. We are indebted to this company for the information from which this description was prepared.

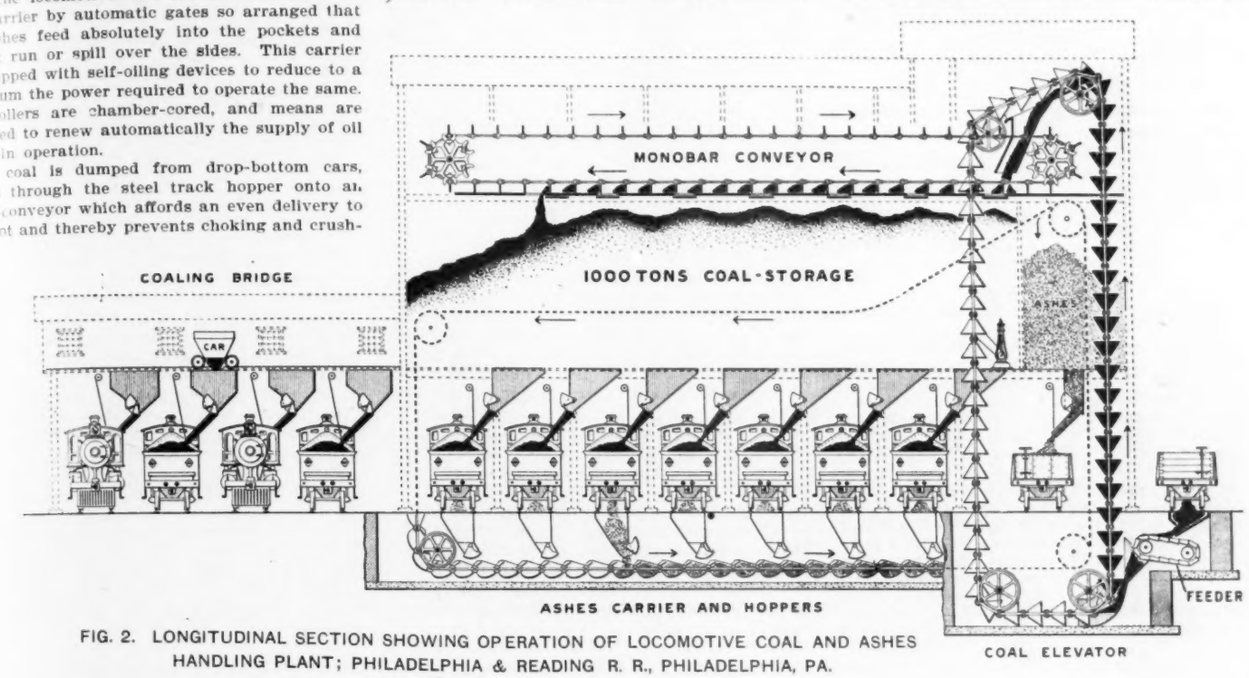

FIG. 2. LONGITUDINAL SECTION SHOWING OPERATION OF LOCOMOTIVE COAL AND ASHES HANDLING PLANT; PHILADELPHIA & READING R. R., PHILADELPHIA, PA.

EXPERIMENTS ON WINTER IRRIGATION OF DECIDUOUS ORCHARDS IN SOUTHERN ARIZONA.

Some interesting studies of winter irrigation of apricot and peach orchards are reviewed in Bulletin No. 37 of the Agricultural Experiment Station, Tucson, Ariz., by Mr. Alfred J. McClatchie, Agriculturist and Horticulturist of the station. While the studies relate chiefly to the cultural side of irrigation they have an important bearing on the design of irrigation works, since in Arizona and in other portions of the West dependent on irrigation there is more water available for irrigation in winter than in summer. The summary and conclusions, as given in the bulletin, are as follows:

(1) Fruits can be grown in the valleys of southern Arizona only by irrigation, the supply of water for which comes from the higher elevations where precipitation is much heavier.

(2) The heaviest rainfall is during midsummer, but the largest supply of irrigating water is during the winter, the supply during the latter period being over three times what it is during the former.

(3) The general practice previous to beginning the experiments was to irrigate orchards once or twice a month, from February or March until October, the belief being quite general that under the trying summer conditions of the region winter irrigation was of little value, or at least entirely inadequate.

(4) The purpose of the experiments was to determine how much summer irrgation might be rendered unnecessary by the liberal application of water during winter when the supply was comparatively abundant.

(5) During the first year of the experiment the orchard was irrigated eight times from Jan. 9 to March 30, 1899, followed by thorough plowing and summer cultivation. The only water applied during the summer was a small amount to three-fifths of the orchard June 24.

(6) The climatic conditions of the growing season of 1899 were somewhat more unfavorable than usual, the rainfall being about normal, the relative humidity some below normal, and the temperature above normal.

(7) The orchard remained in excellent condition throughout the summer of 1899, making a vigorous growth and bearing a heavy crop of fruit of superior quality.

(8) During the second year of the experiment the orchard received 3 ft. of water from Dec. 16 to March 5, 1900. Following the irrigation, the orchard was plowed about a foot deep; by thorough cultivation, a mulch of 6 to 8 ins. of loose soil was maintained throughout the summer.

(9) The weather of the eight months following March 5, 1900, during which the orchard received no water, was very trying upon all vegetation, the rainfall being considerably below the average, the relative humidity below (part of the time very much below) the normal, and the temperature above the normal.

(10) The condition of the orchard at the end of this trying season of 1900 was most excellent, the trees having made a vigorous growth, and at no time having shown the effects of the drought.

(11) During the third year of the experiment a green manuring crop of clover was grown in the experimental orchard (as had been done in the other orchards of the farm for two previous years), and 4 ft. of water applied from Nov. 6 to March 29. A heavy crop of clover was turned under April 6, 1901.

(12) The excellent condition of the winter-irrigated and summer-cultivated orchard at the end of trying seasons was due to the fact that by this treatment a maximum amount of the irrigating water is stored in the soil and returns through the trees, due to the more abundant supply of water during winter, to comparatively slow evaporation while the water is being applied, and to the efficacy of the surface earth-mulch that can be maintained throughout the summer.

(13) The water of summer irrigations, upon account of the insufficient supply and rapid evaporation, does not ordinarily reach deep-seated roots and return through the trees, but irrigations cause a baking of the surface and a growth of weeds that make extra cultivation necessary.

(14) The surface earth-mulch (which can be secured only by cultivation) conserves the moisture stored in soil by checking capillary action, and by preventing evaporation from all the soil except the mulch itself; and it also permits air to enter the subsoil freely.

(15) The results of the underground investigations illustrated, among other things, the superior ability of fine soils to absorb and retain moisture, and the inability of coarse soils lying next to fine soil to long retain much water.

(16) The moisture content of the upper 25 ft. of soil was effected appreciably by above-ground operations and local climatic conditions.

(17) The ground water evidently affects the moisture content of clay 8 or 10 ft. above it, the per cent. of water in the respective feet of that stratum decreasing as the water-level falls, and increasing as the water-level rises.

(18) Growth of rootlets begins on deciduous trees, in our climate, about a month before there are indications of growth above ground.

(19) The set of samples taken June, 1899, showed that about 15 ins. of water had been lost from the upper 25 ft. (of which the upper 5 ft. lost about 8 ins.), and that from the 16th and 17th ft. considerable water had percolated into the drier soil below.

(20) From June 18 to Sept. 30 there was a loss of but a little over 3 ins. of water from the upper 25 ft., of which the upper 5 ft. lost a little over 2 ins.

(21) The total loss of water from the upper 25 ft., during the spring, summer and autumn of 1899, was about 20 ins., of which about 80% was lost the first three months, about 16% the next three, and only about 4% the last three months.

(22) Deciduous orchards use and need the major part of the water supply during spring and early summer, which need can best be supplied in most of southern Arizona by filling the subsoil with water during the winter.

(23) The amount of water needed by a deciduous orchard to keep it in good condition in southern Arizona from March to November is about 21 ins., which can be stored in the soil by the application of about 3 ft. during winter.

(24) The amount that need be applied to grow a green manuring crop and store enough water in the soil to carry a deciduous orchard through the summer is about 4 ft.

(25) Deep winter irrigation followed by thorough summer cultivation is better for deciduous orchards in southern Arizona than the frequent application of small amounts of water during the growing season.

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Thirty-five years ago the city of St. Louis sent Mr. Jas. Kirkwood abroad to study European methods of water purification. In a report which was for 25 years the only comprehensive review of water purification in the English language, and which was translated into German, Mr. Kirkwood advised settling reservoirs and filter beds for St. Louis. Settling reservoirs of ample capacity were built, and with the change in the location of the intake, a few years ago, somewhat larger sedimentation basins were provided. Further than this, Mr. Kirkwood's recommendations were never carried out. Since the report was made many things about filtration have been learned. We are now aware that filtration is more than a straining process for the removal of suspended matters and that the specific danger from organic pollution is the typhoid bacillus. We have also learned that the latter may be removed by filtration; or at least that the total bacterial contents may be reduced almost to nothing, and that typhoid-stricken communities find relief immediately after the installation of a good filter plant. St. Louis has had altogether too much typhoid for years past, but until recently the frequent and sometimes decided agitation for purer water, although endorsed by the water department, fell on deaf ears in the city council. At last the council has made an appropriation of $25,000 to study the water question, and Mayor Wells has appointed Messrs. Allen Hazen, George Y. Wisner and Benezette Williams to take up the work. It is understood that a thorough investigation of all phases of the subject will be made by this commission. Its course of action and its report will be awaited with great interest by engineers in general, as well as by the people of St. Louis. It will be particularly interesting to see how its conclusions tally with those drawn so long ago by Mr. Kirkwood.

The preliminary conclusion in favor of permitting bacterial sewage treatment without subsequent application to natural land areas, just announced by the Royal Commission on Sewage Disposal, will be a great relief in England. It may be expected that this announcement will be followed by a less rigid insistance, by the Local Government Board, on land treatment, regardless of the nature and extent of the more artificial methods of purification employed. It is to be presumed, also, that the conclusion will have some effect on sewage purification in America. It is a notable fact, however, that the most prominent American sanitary engineers have been very conservative in their opinions as to the efficiency and ultimate economy of septic tanks and rapid filter beds. Not long ago the Ohio State Board of Health disapproved of such a system for Columbus, O., and subsequently Mr. Rudolph Hering, M. Am. Soc. C. E., advised that the proposed septic tanks be supplemented by intermittent filter beds. The people of Columbus have just put a most decided veto on the plan, however, but doubtless the heavy expenditure involved, rather than the merits of the case, was responsible for this. Mr. C. H. Rust, M. Am. Soc. C. E., City Engineer of Toronto, Ont., has recently made a valuable report on his inspection of English sewage disposal works. While he was so favorably impressed with the bacterial methods which he saw that he stated Toronto would find them "thoroughly efficient and satisfactory," yet he adds that

> at present there is not sufficient data upon which to base an estimate of the annual cost of operation, nor is there sufficient information to decide finally as to the lifetime of the beds.

So far as Toronto is concerned, Mr. Rust recommends disposal by dilution. In an address before the Iowa Engineering Society, last January, Prof. Anson Marston, of Ames, Ia., stated that "the new methods do not give anywhere near the degree of purification which intermittent filters secure in America."

Engineers and local authorities in this country should bear in mind the fact that land suitable for intermittent filtration or broad irrigation is very scarce or entirely lacking in the vicinity of many English mnuicipalities; also that the sewage is generally stronger and the streams which receive sewage effluent smaller than is the case in America. In many sections of this country sandy and gravelly land is abundant at no great distance from cities. In such cases it is not surprising that conservative engineers favor intermittent filtration, which experience has shown to be so satisfactory here, rather than the uncertain efficiency and life of so-called bacteria beds. The septic tank as a substitute for chemical precipitation, however, seems to have won for itself a better status. Doubtless there will be conditions under which rapid filtration will be preferable to intermittent filtration, in America as in England, but, as Mr. Rust and others have well said, we lack data on this point.

THE USE OF CONCRETE IN RAILWAY STRUCTURES.

One of the most striking features of railway construction and improvement work during the past few years is the great extent to which concrete has been used, and the varied purposes to which it is applied, either alone or in combination with steel in the form of rails, beams, rods, netting, etc. The use of concrete is, of course, in itself no novelty, but until quite recent years its use was confined almost exclusively to foundations, backing and similar work which would be buried or concealed. It was also occasionally used for minor structures, which would be inconspicuous, but for exposed and important masonry work, brick or stone was almost universally employed. Now, however, concrete is used for various exposed works, not only in minor structures, but also in large structures of engineering or architectural importance, in some of which the appearance is one of the points to be considered. Thus we have concrete arch bridges, bridge piers and abutments, culverts, tunnel lining, retaining walls, grain elevators, tanks, buildings, etc., as well as such auxiliary works as dams, sewers, subway constructions, etc. Concrete is also being very largely used for strengthening and repairing brick and stone masonry which is insufficient for the loads to which it is subjected, or which may be disintegrating under atmospheric influences. The concrete work may include simply a jacket or casing to protect the original masonry, or it may be used for enlarging and strengthening the particular pier, arch or other structure.

The main advantages of the use of concrete are its low cost, its universal applicability, the rapidity and facility of its construction, and its greater reliability and permanence as compared with cheap stone masonry. It costs practically nothing for maintenance, as there are no joints to be pointed up, and it is not subject to decay. In first cost, it presents special advantages over first and second-class masonry in localities where building stone is scarce and has to be brought from considerable distances. It is to be noted, however, that it is also being very extensively used, even in localities where good stone is readily obtainable. Concrete also presents advantages in the renewal and repair of existing works, and the construction of new works, under conditions where non-interference with traffic is an important matter. The materials can be hauled at small expense, and the work can be done with great facility, without requiring the use of heavy machinery such as cranes or derricks. Skilled labor is not required, and where the amount of work is sufficient to warrant the use of mixing machines, a large proportion even of the unskilled labor can be dispensed with. With these various advantages, and in view of the fact that the concrete structures can readily be made pleasing in appearance, there is little wonder that this material is coming into such extensive use as has already been shown.

For bridge work, concrete can in general be built more cheaply than stone masonry, where only a small amount is required. Where a large volume is required, however, good stone masonry has been built at about the same price as first-class concrete. This is only practicable under very favorable conditions, but is said to have been done on the Illinois Central R. R. That it is exceptional, however, is shown by the fact that this road is making very extensive use of concrete for a variety of structures, as shown by an illustrated article in our issue of July 18, 1901. In the report of the Committee on Railways, presented at the annual meeting of the Illinois Society of Engineers and Surveyors, in 1900, it was stated that for small pieces of work on existing roads, the carpenters and construction gangs can readily put in the temporary work and build the forms. A work train can then be sent out with cement, stone, sand, mixing machines, etc., and the concrete put in very rapidly.

In foundation work, a clean base of sufficient area should be obtained, and the excavation kept dry. The cofferdams or sheeting should be waterproof, but if the ground is pervious and the concrete must be deposited in water, it should be deposited by means of chutes reaching to the bottom, and moved from place to place, as required to distribute the concrete over the area.

In the construction of the wooden forms, the principal feature is strength to support the plastic mass during the process of setting. For exposed work, however, another important consideration is that of procuring a smooth, finished surface. This requires a sheathing of planed and closely-jointed planks, free from knots, and forms of this kind are, of course, much more expensive than those consisting simply of rough planks. A lining of heavy paper may also be used to give a smooth face to the concrete. For all exposed work, built within the ordinary style of form care should be taken to have the planks even and parallel, so as not to leave irregular and unsightly lines across the face of the work, indicating the joints between the planks. The forms may be coated with grease to prevent the concrete from adhering to the planks.

For large and high pieces of work, it may be desirable to stiffen the frames of the forms by transverse tie-rods, these being removed as the work progresses. The upper rods (above the top of the finished masonry) should, however, be left in place until the forms are removed. In some work it is preferred to leave the tie-rods embedded

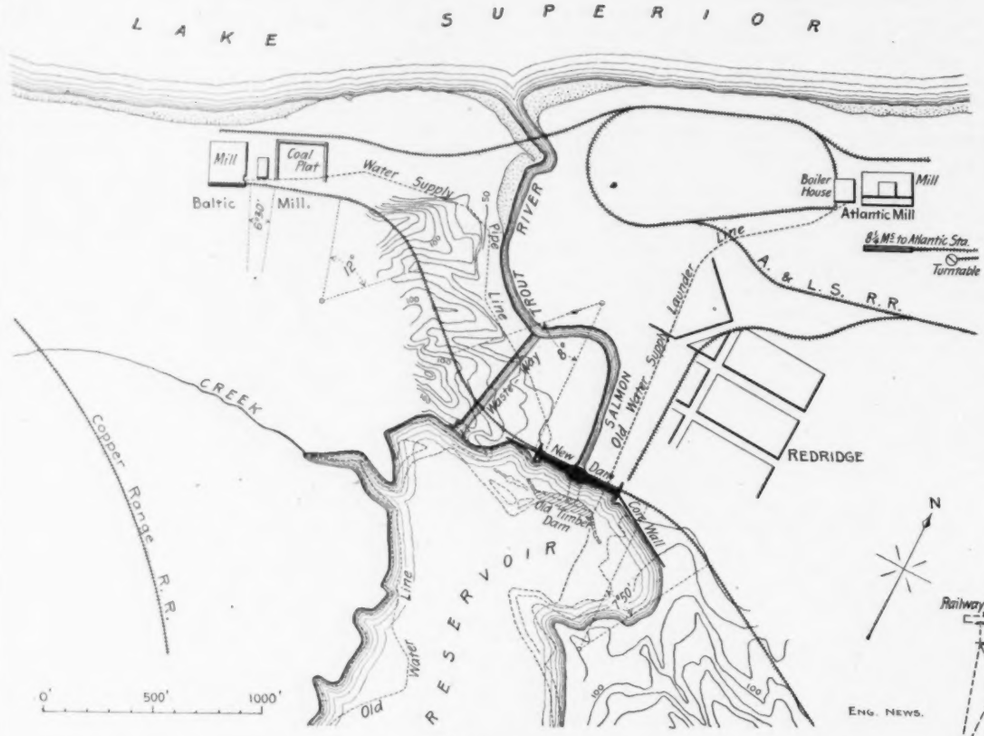


FIG. 1.

MAP SHOWING LOCATION AND SURROUNDINGS.

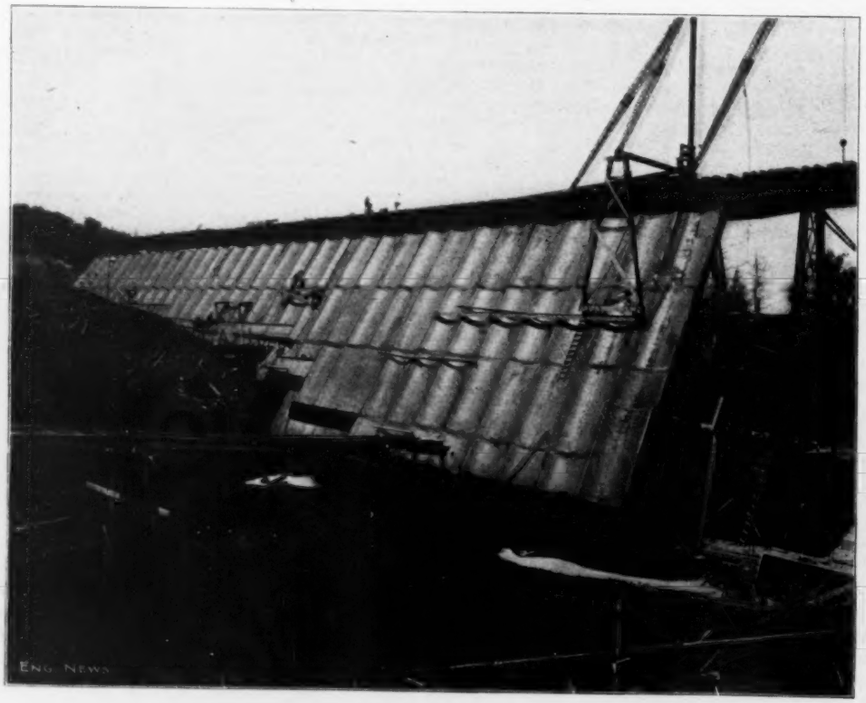


FIG. 5.

VIEW OF STEEL WORK OF DAM.

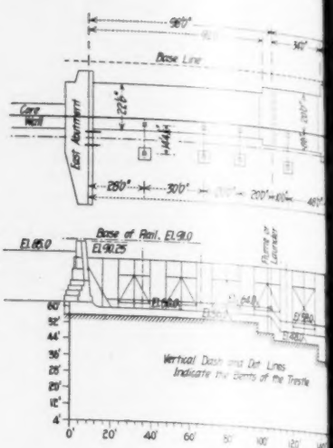


FIG. 3. P

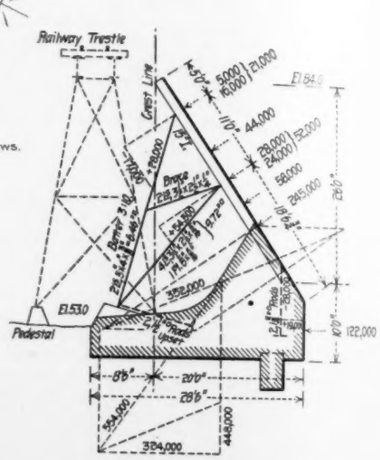


FIG. 4.

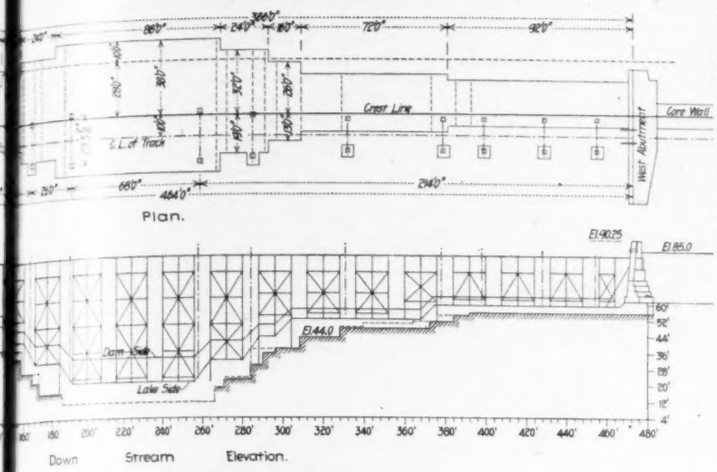
CROSS-SECTIONS OF DAM.

STEEL DAM WITH CONCRET
AT REDRIDGE, M

Foster Crowell, M. Am. Soc. C. E.,
C

Wisconsin Bridge & Iron Co., Milw
Contract

Prendergast & Clarkson, Chicago,
Contractors



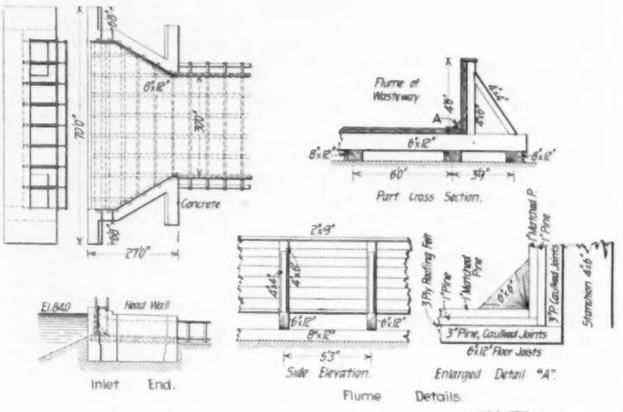


FIG. 3. PLAN AND ELEVATION OF DAM.

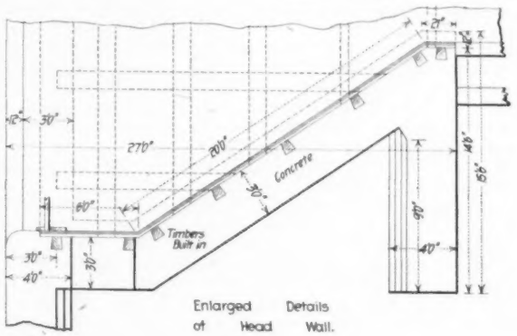
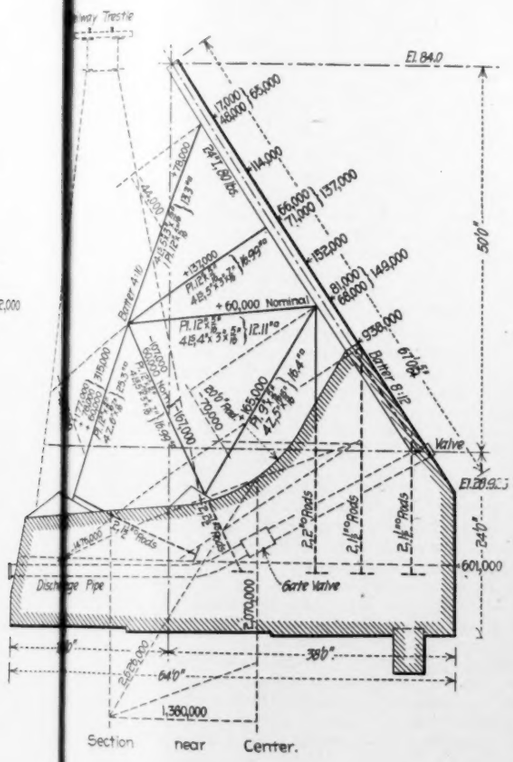


FIG. 6.

WASTEWAY FOR RESERVOIR FORMED BY THE REDRIDGE DAM.



WITH CONCRETE FOUNDATIONS
T REDRIDGE, MICH.

Am. Soc. C. E.,
Consulting Engineer.

& Iron Co., Milwaukee, Wis.,
Contractors for Steel Work.

rkson, Chicago, Ill.,
Contractors for Concrete Work.

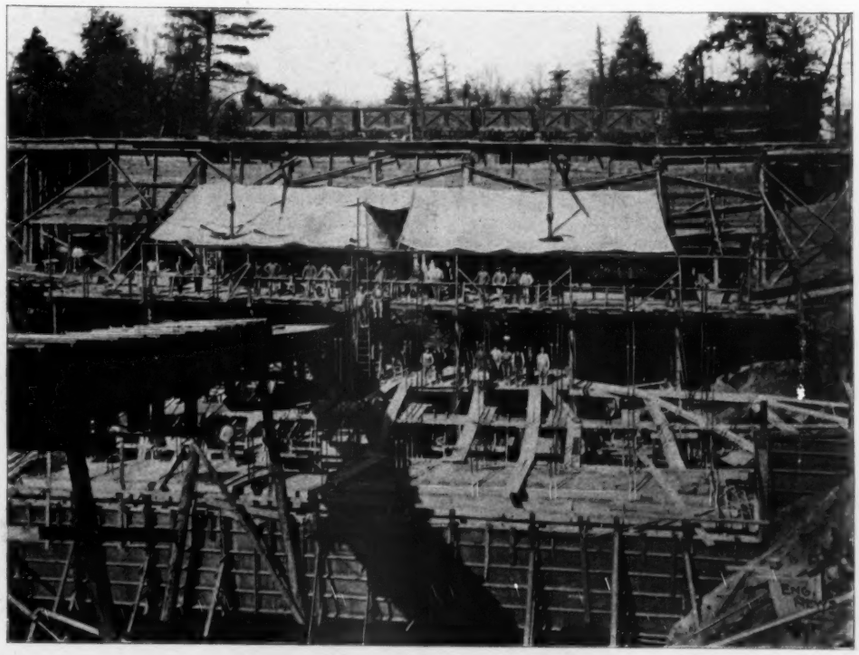
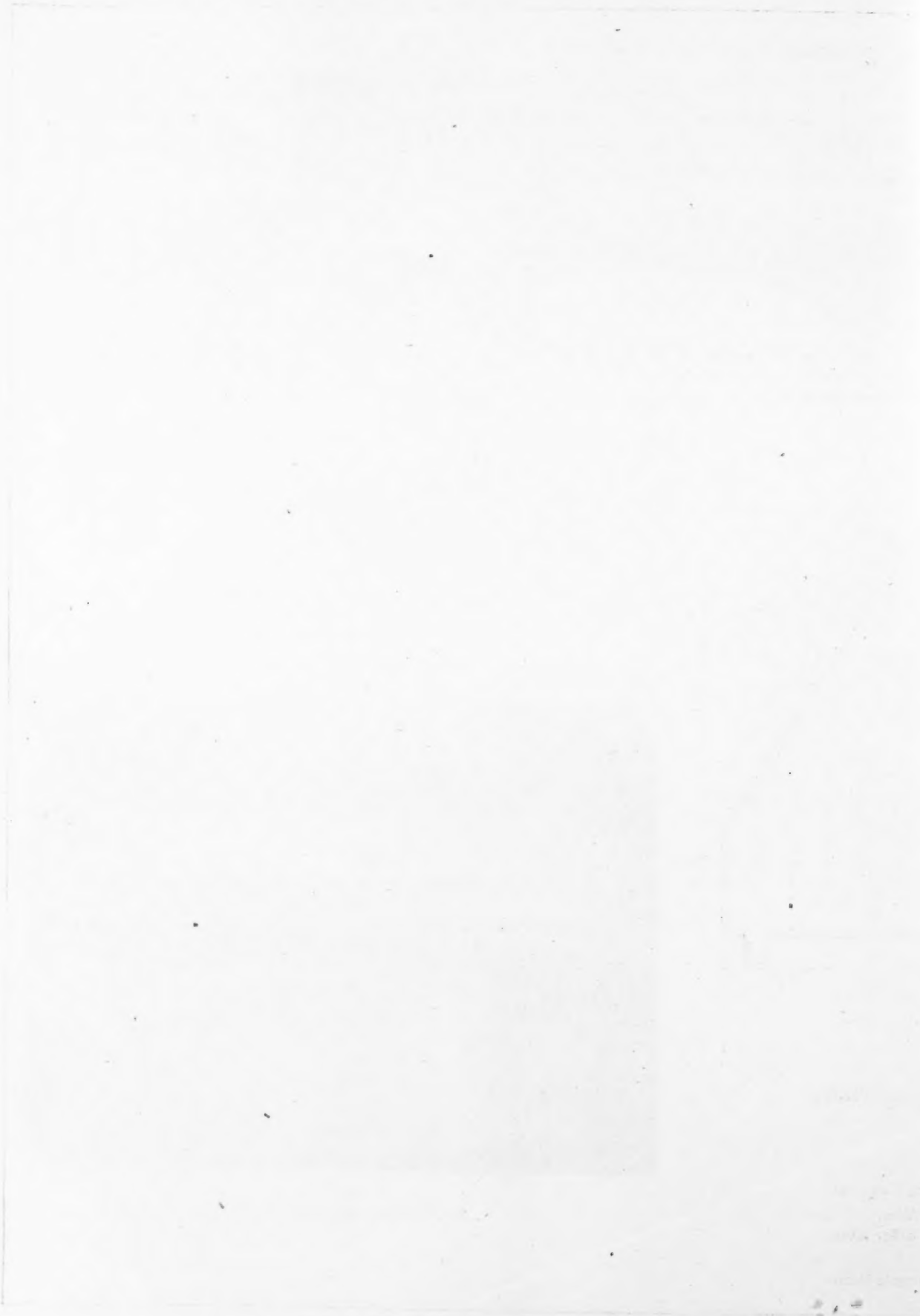


FIG. 2.

VIEW OF DAM UNDER CONSTRUCTION.



in the concrete, and in order to prevent the unsightly appearance of the projecting rods, each rod is made in three parts. The two end pieces (which extend through the form) are connected to the middle portion by sleeve nuts or turnbuckles. When the form is removed, the short end pieces can be unscrewed, leaving holes which are filled with cement and plastered over. Wire ties have also been used, the ends being cut off ¾-in. back from the face and the holes plastered over.* The forms are generally left in place at least 48 hours, and longer in cold weather.

For arch work, the tendency of the centering to rise at the crown while the load is applied at the haunches as the concrete laying commences, must be provided for in the design of the centering, or the centers must be temporarily loaded at the crown, the load being regulated so as to prevent distortion of the arch as the work progresses. The centering must be designed to provide for a suitable settlement of the crown of the arch when the centering is removed, which is usually not less than 28 days after the concrete laying has been finished, or longer in cold water. The concrete arch is usually laid in sections, transverse to the axis of the arch. Each section extends from spring line to spring line (the walls having previously been built), and is completed without any cessation of the work.

Any good hard stone may be used, granite, trap or limestone being most common, and sandstone being generally forbidden. The stone must be clean, and it is sometimes required to be screened free from stone dust. The size is generally limited to 1½ or 2 ins. in the maximum dimension, while a ¾-in. granite is preferable for bridge seats, pedestal blocks, etc. Gravel is sometimes used in concrete, either alone, or as forming not more than 50% of the specified amount of stone. The specifications of the Illinois Central R. R. (Eng. News, July 18) call for "tough, hard, clean limestone, screened through 2-in. meshes or holes." These specifications are exceptionally strict as to the character of the stone.

The fine dust which results from the crushing of the stone should not be mixed with the concrete, as it reduces the strength. Mr. Butler, in his "Manufacture and Use of Portland Cement," says that in his experiments while sand contained only 0.2% of loamy matter removable by washing, the limestone screenings lost 20% of fine dusty matter. Tests made with mortar showed that at 21 days the strength of the briquettes made with washed ⅜-in. screenings was 55% higher than that of briquettes made with the unwashed screenings.

In several structures, a natural cement concrete has been used for the main body or core of the mass, with a Portland cement concrete for the facing or exposed portion. Instances have been given, however, which indicate that it is difficult to make a thorough bond between the two classes of concrete, and that there is liable to be a line of separation between them. Natural cement may be used in foundations, etc., but for walls, or other exposed work where Portland cement is to be used, it is considered better to use this cement throughout. Economy may be effected by using a poorer mixture of concrete for the interior of the mass, rather than by using a different kind of cement.

There is considerable diversity of opinion as to whether concrete should be mixed with large or small proportions of water. While wet concrete, even to a degree of slushiness, is used in some cases, general practice and the weight of opinion appears to be decidedly in favor of using concrete pretty dry, and relying upon good ramming to fill the voids, the consistency being such that thorough and hard ramming is necessary to cause water to flush to the surface to show a quaking motion in the mass. Some specifications, however, require that the concrete must not quake in ramming.

In the book already mentioned, Mr. Butler states that as a general thing excess of water is preferable to an insufficiency, for the reason that the concrete may be laid in a trench in porous soil, which will absorb some of the water, or the materials of the aggregate may be porous and also absorb water, while with a quick-setting cement and a minimum supply of water, there might be danger of the concrete setting too quickly. The absorption of water by porous material in the aggregate should be prevented, by wetting the stone, etc., in the first place, as is provided by some specifications. Where none of the above conditions prevail, however, Mr. Butler admits that there is no doubt that the minimum amount of water gives the best results.

That point (the minimum amount) is reached when by ramming and punning the mass, the water just shows on the surface, indicating that exactly sufficient has been used to lubricate, so to speak, the constituents of the concrete, and enable them to flux down together into a compact mass. If more than this amount is used it will be impossible to obtain such a solid concrete, owing to the space occupied by the excess of incompressible water; while, on the other hand, if less is used, the mass will not flux properly, and will thus be rendered porous. Of the two extremes an excess of water is preferable, as less likely to lead to dangerous consequences.

On the other hand, Mr. Jameson, in his "Portland Cement," says that the concrete when ready to be deposited should be merely a damp incoherent mass; the amount of water is almost universally too great, but there is very little danger of using too little water. If no more than the proper amount of water has been used, the tamping will be sufficient long before any of the water appears on the surface.

An interesting experiment conducted on the Chicago, Milwaukee & St. Paul Ry., to determine the comparative strength of concrete made with a maximum and minimum amount of water, was recoreded in a paper read before the Western Society of Engineers last winter (Eng. News, March 28, 1901). The conclusions arrived at were as follows: (1) A moderate excess of water is not injurious; (2) more labor is necessary in mixing and placing a dry or moderately dry concrete than a wet concrete; (3) it is impossible to get a compact concrete without using what is, theoretically, an excess of water. It will, of course, be evident that the dry mixture will require very much more ramming to fill the voids, but in a mixture so wet that the men sank almost to their knees in it (as actually used in at least one case), there would seem to be a liability for the heavier particles of the mass to settle to the bottom of the layers. The advocates of the wet mixture claim that with dry mixtures the voids are never thoroughly filled, even by long-continued ramming, and that in fractured surfaces the stones can often be pulled out of the mass, showing a lack of homogeneity. In our issue of May 2, 1901, there was described the construction of irrigation conduits in Colorado, where a wet concrete, that required no ramming, proved stronger than a dry concrete. In fractured surfaces, the stones would break, instead of pulling out, showing how firmly they were held by the surrounding mortar. In the specifications of the New York Central Ry., Southern Pacific Ry., etc., it is stated that the concrete must not be so wet that it will quake when rammed. As a matter of fact, there is a rather bewildering diversity of opinion and practice upon this point. This is shown very clearly by the report of the committee on concrete, presented at the annual meeting of the Association of Superintendents of Bridges and Buildings (Eng. News, Oct. 18, 1900).

At one time concrete mixed by machine was looked upon with considerable disfavor, and its use was in some cases forbidden. It is now generally recognized, however, that machine-mixed concrete is at least as good as that mixed by hand, and in fact that it is often superior to the latter. The machine does its work uniformly and regularly, while men who are careless or working in a hurry may slight the work and give the materials an insufficient mixing. A majority of the numerous mixers in use are of the rotary type, consisting either of revolving boxes, in which the materials are shaken violently about, or revolving drums, in which the motion is much less violent. A machine of quite another type is the gravity mixer, which has a hopper ending in a long inclined trough or chute filled with deflecting blades and pins. The measured quantities of stone, sand and cement are spread one upon the other on the platform, and then shoveled into the hopper, whence they slide down the chute, being diverted from side to side so that the contents are ultimately mixed and fall from the chute as concrete ready for use. Whether the mixing is done by hand or machine, the water should be added by a spray or sprinkler, and not thrown on in bucketfuls or by a hose.

A common defect in ordinary concrete work, such as bridge abutments and wing walls, is the use of sharp angles and corners. These are natural enough with stone masonry, but with a plastic material such as concrete it would be better in many cases to round off or bevel these parts. Some engineers require the corners of exposed work to be beveled off, by filling in the corners of the form with sticks of triangular section. Another unsightly appearance is that due to forming the tops of wing walls in rectangular steps. In stone masonry these steps represent the courses, and are natural, although often needlessly ugly, by being unprovided with coping or cap stones. In concrete, however, there would be little additional expense or trouble involved in making the top of the wall on a slope conforming to the slope of the bank. This may be done in first construction, or subsequently, the original work being roughly stepped, as the layers of concrete are deposited in the forms.

Where a fine finish is required, two methods are available: First, the facing may be formed as the work progresses, being built up with and forming a homogeneous part of the mass of concrete: second, it may be formed by plastering upon the face of the completed work. The former is undoubtedly the better and the more permanent. To lay the facing in this way, a board or iron plate may be taken, and fitted with two cleats on one side. This is set against the face of the form, the cleats maintaining a space between the form and the plate. The fine facing mixture is laid in this space and the ordinary concrete deposited behind the board, which is then drawn up and the material rammed so as to form a solid mass. In many cases, however, where it is simply desired to prevent the appearance of stones at the face, the forms are plastered with a cement mortar (1 cement to 2 sand) for a thickness of 1 to 2 ins. just before each layer of concrete is deposited.

The method of applying a separate plaster coating to the work does not appear to be much practiced or favored at this time. Two cases in which the concrete was finished in this way may be cited, however. The piers of the Arkansas River bridge, of the Kansas City Southern Ry., built in 1896 (Eng. News, Aug. 25, 1898), were given a ¾-in. coat of cement plaster, put on in three layers ¼-in. thick. The first two layers were composed of one part Portland cement (Condor brand) and three parts sand; the last coat was a 1 to 2 mixture. In the original concrete work no attempt had been made to keep the stone from the surface, and the only treatment given before plastering was to wet the concrete thoroughly before applying the plaster. Mr. A. F. Rust, Resident Engineer, informs us that there has been no scaling or cracking of the plaster, except in that which was put on in freezing weather. The present practice of this road in building concrete work, however, is to work the stone back from the face of the form by means of a shovel. In the Kaskaskia viaduct of the Chicago & Eastern Illinois Ry., built in 1896, the concrete pedestals were plastered in from one to three weeks after the forms had been removed. Nothing was done to the surface of the concrete except to wet it thoroughly. It was intended to put on a 1-in. coat of mortar, but such a thickness could not be made to adhere, and it was therefore applied in two coats, the second one an hour or two after the first. The plaster was composed of 1 part Portland cement to 1 part sand, and had a total thickness of ½ to ¾-in. Mr. E. S. Markley, Superintendent of Bridges and Buildings, reports that the plaster is in first-class condition at the present time. As to this method of finishing up concrete work, Mr. W. S. Dawley, Chief Engineer of the C. & E. I. Ry., informs us that he does not consider it preferable to forming the face as the work progresses. The present practice on this road is to place the mortar for the face next to the form and then to immediately lay the body of the concrete behind it.

*Annual report of Illinois Society of Engineers and Surveyors, 1900; report of Committee on Railways, p. 113.

Where a specially elaborate appearance is desired, the surface is sometimes treated to represent stone, a practice which is not to be recommended either on the ground of the appearance or of artistic taste. It is much better to design the work with panels, mouldings, etc., which will not be simply imitative, and for the decorative treatment tinting matter may sometimes be used in the concrete for different parts of the work.

In general it is assumed as bad practice to build concrete work in freezing weather, but as a matter of fact such work is carried on regularly in the most severe weather, and with success. The report of the Committee on Masonry, presented at the annual meeting of the American Railway Engineering & Maintenance of Way Association in March, 1901, contained the following remark upon this point:

> Examples of excellent and durable work in our colder climates are not wanting, and work put up in zero weather affords ample indication that with proper care and precaution concrete masonry can be constructed at a season of the year when it would be unwise to attempt stone or brick masonry. We would especially emphasize the necessity of heating the stone as well as the sand before mixing in very cold temperatures.

For cold-weather concrete the materials should be heated, lime used instead of clear water for mixing, and the green concrete should if possible be protected from freezing. Concrete culverts have been built in South Dakota and have withstood the most severe weather. At Buffalo, N. Y., the Delaware, Lackawanna & Western R. R. built some concrete work in water during cold weather, and finished the upper part above water, when the temperature was — 15° F. The forms were housed over with wooden rooms or cabins, which were heated by stoves, and in these the work was done. While there is a general impression that concrete masonry should not be laid in winter, yet on the Canadian Pacific Ry. (which passes through regions subject to very severe weather) concrete construction has been carried on almost every winter since 1876, and in some special cases the work has been going on all the winter. This statement was made by Mr. P. A. Peterson, the Chief Engineer, at the meeting above referred to. Mr. Spaulding, in his "Hydraulic Cement," says that salt and cold have different effects upon different cements, and that where concrete is to be laid at low temperatures the effects of salt and cold upon the cement to be used should be determined.

Concrete that is really waterproof or impervious to water without additional treatment seems to be very difficult to obtain, in spite of the various recipes given for its manufacture. Mr. Butler ("Portland Cement; Its Manufacture and Use") says that for such concrete 77% of its volume must consist of dry cements and sand (51.3% sand and 25.7% cement). This would give approximately proportions of 1, 2 and 4. Other authorities say that the only requirement is to make a very rich mixture, so as to ensure that there will be no voids. In practice, however, some exterior coating of tar or asphalt (with or without tarred paper or felt in combination) is usually found necessary, while in some exceptional cases a riveted steel plate facing is built outside the concrete, painted with asphalt and well grouted behind.

In very many cases, concrete structures are now reinforced by the use of steel beams, steel rods or sheets of steel netting embedded in the concrete. In concrete foundations, especially, rails and beams have been extensively used, while the netting has also given excellent results at much less cost. In arched structures, steel beams, and even built-up lattice girders, are frequently employed, acting as arch members, but in the concrete arches as adopted by the Illinois Central R. R. rows of I-beams are simply laid horizontally over the crown of the arch, to bond the mass together and to distribute the loads.

Rubble concrete, having large rough blocks of stone embedded in the concrete, is sometimes used for dams and retaining walls, care being taken to have at least 4 to 6 ins. of well-rammed concrete between the blocks. Mr. Butler, however, recommends a minimum of 18 ins. This construction does not affect the strength, but reduces the cost, since less cement mortar is required in the mass.

LETTERS TO THE EDITOR.

The Advantages of Concrete as Compared with Rubble Masonry.

Sir: The letter from Mr. Walter Seely, published in your issue of Aug. 1, on the advantages of concrete as compared with rubble masonry, seems to call for a few words in defence of the latter.

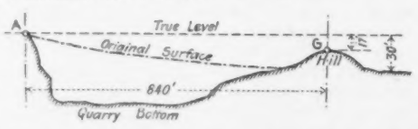
The continued use of rubble masonry in engineering works in this vicinity is principally due to the fact that with equal care in construction, a rubble wall can be built equal in strength and durability to a concrete wall, at from three-quarters to one-half the cost of the latter. The reasons for this are: First, that stone suitable for rubble masonry can be procured for almost a nominal sum from excavations that, if not on the site of the work itself, are generally being carried on close at hand. On the other hand, broken stone for concrete costs about from $1 to $2 a cu. yd., depending on the distance of the work from the nearest wharf. Second, while six-tenths to three-quarters of a barrel of cement will generally suffice to lay up a cubic yard of rubble masonry, properly proportioned concrete will take from a barrel to a barrel and a half to the cubic yard. Third, the cost of labor on rubble work is generally less than that on concrete, especially if there are to be mold boards for the latter for light or intricate shapes.

Another advantage of rubble masonry is that with a little care an exposed face can be given a most artistic appearance with but slight increase of cost. The exposed face of a concrete wall, even when great care has been expended on the mold boards and ramming, seldom has an artistic appearance, although it may delight the engineering eye. Used for a backing for cut-stone masonry, rubble is quite as good as concrete, and in backing up broken range ashlar it is almost impossible to make a good job with the latter. I think it is generally conceded that a mass of rubble masonry is much less liable to crack from changes of temperature or composition than a similar mass of concrete. Concrete has numerous uses in foundations, monolithic blocks, in combination with iron and steel, etc., but I think that Mr. Seely will find on closer investigation that it cannot properly take the place of the rubble masonry which he observed "in the large engineering works in the vicinity of New York."

Yours very truly,
Alger C. Gildersleeve, Assoc. Am. Soc. C. E.
New York, N. Y., Aug. 6, 1901.

An Optical Illusion.

Sir: A curious optical illusion, which misled three trained surveyors, occurred recently in my practice and may be of interest to your readers. A stadia traverse, nearly 3,400 ft. long, with seven stations, A, B, C, D, E, F and G, was run around a quarry property, the vertical angles being also read in order to determine the elevations. On computing the work the horizontal angles checked satisfactorily and the polygon closed within 2 ft., but an error of 35 ft. was found in the levels. This was naturally supposed to be due to an error in reading, such perhaps as reading 10° 25′ instead of 5° 25′. It was seen, indeed, that if the signs of the angles at A and G were reversed the discrepancy would disappear, but there seemed absolute certainty that G was higher than A, and the notes showed the vertical angle at A to be + 1° 17′ and that at G to be — 1° 17′, so that this hypothesis could not be entertained. The vertical angles were then remeasured starting at B and going in order around to G, but no errors were found. Imagine then our surprise when standing at G and apparently looking down toward A the angle was found to be + 1° 17′ or one of elevation, while the backsight from A, where we apparently looked up toward G, gave the angle as — 1° 18′.



The transitman who read the vertical angles on the first day was a young man of three years' experience in stadia work, but the optical deception lead him to call out the vertical angle at G as minus and that at A as plus, and the recorder noted them without question, as the same impression was in his mind. All engaged on the work were agreed that G was higher than A, and the conviction was so strong that this line was the last one to be observed on the resurvey. The reason for the deception or illusion may be seen from the accompanying sketch. The station G was on a small hill about 30 ft. higher than the foot of the original surface slope leading down to it from A. Standing at A the eye unconsciously supplied this slope even though it was looking out across the quarry excavation, and, furthermore, it assumed that the original surface was level, the impression that G was higher than A of course naturally followed. The same impressions, strange to say, appeared to be true when standing at G, which thus again seemed to be the higher point. The moral of this story, is, of course, very plain; a transitman, even if of long experience, should always look at his level bubble when reading small vertical angles.

This survey furnishes a good illustration of the accuracy and rapidity of stadia work in determining elevations. The total vertical rise from the lowest point G to the highest one D by the route G, A, B, C, D was found after the error due to the optical deception had been corrected, to be 175.7 ft., while the fall from D to G by the route D, E, F, G came out 175.3 ft. This agreement by far closer than that needed for the purposes of the survey, while the entire work both horizontal and vertical was done in one-fifth of the time that the old methods by chaining and leveling would require.

Yours truly, R. Stadia.
Trenton, N. J., July 23, 1901.

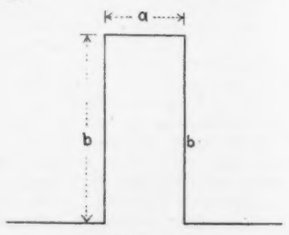
The Relative Cost of Solid-Fill and Creosoted Pile-Supported Piers.

Sir: Recently I have had occasion to look into the relative costs of solid-fill and creosoted pile-supported wharves on piles, and I send you in condensed form the result of my investigations. I may state that the bulkhead considered below is of heavy creosoted sheet piling tied back to two rows of anchor piles, and includes a narrow "apron" supported on piles, and located just outside the bulkhead. The "apron" permits some earth slope from the channel up to the sheet piling, thus removing some strain from the latter. This character of bulkhead is much used in southern waters. There is perhaps 20,000 lin. ft. of it at Galveston, Texas.

It is the belief of the writer that a cheaper and better bulkhead than the above could be built of I-beams and concrete, and if this be so, it is an added argument for solid-fill piers. Where undeveloped wharf front is plentiful and cheap, wide piers affording large storage capacity offer great advantages to commerce over the mere gangways that are of necessity used in such crowded harbors as New York. Even in the latter, however, the tendency is to widen the piers very materially, and the same is the case at Boston, Galveston and other harbors.

While the permissible width of piers may be in some sense an inverse function of the value of wharf-front property, it seems probable to the writer that in most cases the wharf or pier of the future will be built of sufficient width to permit of the berthing of a vessel across its end. A little thought will show that such a course will result in the minimum loss of bulkhead for berthing purposes. Indeed, the only waste bulkhead would be at the inner end of the slip between wharves such as described. The value of such commodious wharves from a transportation standpoint can be readily appreciated.

It is almost obvious that the cost of maintenance should be less for solid-fill than for pile wharves. A pile wharf is always in great danger of destruction by fire. The insurance feature alone should dictate a greater use of solid-fill wharves, even where other things are equal, which generally they are not. In what appears below, the cost of wearing floors, sheds and accessories are not included in either case.



Let a = width of pier, and
b = length of pier.

It is fair to assume that the bulkhead would cost $10 per lin. ft.; that solid fill would cost 10 cts. per cu. yd. pumped over the bulkhead; and that the mean fill would be 11 yds. deep over an area of a × b sq. ft.; also, that a pier supported on creosoted piling, minus the wearing floor, would cost $1.50 per sq. ft. Assume b to be 400 ft. in a particular case, equate cost of solid-fill and pile-supported piers, and deduce value of a:

$$4{,}000\ (a + 2b) + (11 \times 10)\left[\frac{a}{3} \times \frac{b}{3}\right] = 150\ (a \times b).$$

Then a = 62 ft.,

∴ for any width less than 62 ft., a creosoted pile pier would be cheaper, but for any width greater than 62 ft., a solid-fill pier would be cheaper. For example, if the pier were 80 ft. wide the saving in case of solid fill over pile pier would be $8,888. The saving in case of a pier 100 ft. wide would be $19,111.

The cost of a solid-fill pier 100 ft. wide would be but $1,777 more than the cost of a similar pier 80 ft. wide, and the cost of a 100-ft. wide solid-fill pier would be $7,111 less than the cost of an 80-ft. wide pier on creosoted piling. Carrying the comparison still further, a

solid fill pier 800 ft. long and 400 ft. wide would cost the same as a pile pier 800 ft. long and 100 ft. wide. The former would berth one more vessel, and possess four times the storage capacity.

W. V. J., Mem. Am. Soc. C. E.

Montgomery, Ala., July 27, 1901.

Australian Hard Wood and Creosoted Deal Pavements in London.

Sir: Referring to the communication from myself, published in the Engineering News for Aug. 1, and editorially commented upon by you, may I again trespass upon your time to the extent of calling your attention to the following extract from the Forty-fourth Annual Report of the Surveyor of the Vestry of the Parish of St. Mary Abbotts, Kensington, London, for the year ending March 25, 1900.

With regard to the section of the Kensington High St. and Sussex Place, these areas were paved with 4-in. Jarrah blocks in October, 1892, and October, 1891, respectively, but the surfaces became so uneven and dangerous, that it became absolutely necessary to remove the hard wood (which had only been down six years in the one place and seven years in the other) and to refloat the entire concrete surface and repave with creosoted deal blocks. The experience with reference to hard wood paving in Kensington, fully justifies the advice which I gave the vestry, upon its introduction into the metropolis; viz., to proceed with caution, and not to supersede creosoted deal, the suitability and economy of which had been proved in the parish by 20 years' use and experience, in favor of the hard wood then being brought into metropolitan notice, but that the Jarrah and Karri hard wood should be given the opportunity of proving their alleged much-greater durability in order to justify their much greater cost. In certain positions, and under certain circumstances, it may possibly be wise to lay down the hard wood, but from a careful study of this description of paving in various parts of the metropolis, I find nothing to justify the supercession of creosoted deal by Jarrah or Karri, but on the contrary, facts point in the reverse direction.

This opinion upon the Australian hard woods is cited because of the concluding paragraph of your editorial comment. One of the first streets in London paved with Jarrah wood was laid in June, 1889, on Westminster Bridge road, and was wholly renewed in July, 1899, after ten years' service. The bridge itself, to which this road leads, was paved in the same year, 1889, with creosoted deal, and is still in good condition. The use of the Australian hard woods in London was not begun recently, but dates back some twelve years. Yours very truly,

F. A. Kummer, Gen. Mgr. U. S. Wood Preserving Co.
29 Broadway, New York city, Aug. 5, 1901.

(We have made no claims whatever for or against the Australian hard woods. All we did in our issue of Aug. 1 was to call attention to the fact that Swedish deal was by no means the only kind of wood pavement laid abroad. It is easy enough to cite arguments either for or against any kind of paving yet laid down. For instance, in our issue of May 31, 1900, we published an abstract of a report by Mr. D. J. Ross, City Engineer of London (the old area) in which he pronounced both deal and hard wood less satisfactory than asphalt. According to our abstract of his statement,

ordinary deal block pavements have been used in the city of London since 1871, the blocks being mostly 3 × 9 ins. x 6 ins. deep, generally creosoted, laid with bitumen joints on Portland cement foundations.

He then goes on to say that in his experience "the carriageways in streets of considerable traffic have had to be relaid at intervals of from five to seven years." Mr. Ross was not much, if any, more complimentary to the Australian hard woods, but he could not be very definite, since practically none had been down more than 4½ years. Altogether, though, there were some 25,000 sq. yds. of hard wood in the city. Outside the old city, in Tottenham Court Road, hard wood blocks laid 6½ years before "had worn very unevenly," and were "being extensively repaired."

This report by Mr. Ross put the friends of Australian hard woods, and of Australia itself, on their mettle. A pamphlet in rejoinder was at once issued by Sir Edward H. Wittenoom, Agent-General for Western Australia. A three-column abstract of the pamphlet, with its arguments and citations of experience in favor of the Australian woods, was published in our issue of Aug. 23, 1900. The experience of some fifty surveyors, in and out of Greater London, was given. It is needless to say, under the circumstances, that the experience was mostly one way.

One section of the pamphlet relates to the experience of Kensington, the very district involved, as we understand it, in our correspondent's letter. But whether or not the districts are the same a quotation from that section of the pamphlet will serve to illustrate the nature of much of this controversy:

But, in treating of this district, it should be borne in mind that the surveyor is an authority upon and the special advocate of creosoted yellow deal, which he has used with advantage for a number of years.

In the concluding paragraph of our correspondent's letter he compares the results obtained with the Jarrah Australian hard wood on Westminster Bridge Road, with those following the use of creosoted deal, laid the same year, on Westminster Bridge itself, which is a continuation of the road. Is this a fair comparison? The deterioration of pavements, as is well known, is due largely to digging them up to get at water and gas mains and the like. The granite block pavement on the Brooklyn Bridge has been cited as an instance of the long life and moderate repairs of pavements undisturbed by excavations. In our issue of March 15, 1900, we quoted a statement by Mr. A. Brown, of Nottingham, England, to the effect that in Victoria St., in that city, in which there is a subway for pipes and wires, the pavement was not disturbed, nor was there a penny spent for pavement repairs, in 25 years.

We have devoted this much space to Mr. Kummel's letter, not because we are skeptical as to the merits of creosoted pine pavements, nor advocates of the hard woods of Australia, but simply to make it clear that there are two sides to this, like all other questions. We fully realize that wood pavements of any kind have rarely had a fair trial in America, and consequently much of the very general disfavor in which they stand is quite undeserved. But this, as Mr. Kummel is doubtless learning to his sorrow, does not make it so very much easier to secure their introduction.—Ed.)

Holbrook's Spiral Curves.

Sir: I desire to commend the article on "Spiral Curves," by Mr. E. Holbrook, in the issue of June 13 of Engineering News. There is but one true transition curve between tangent and circle, and that is the one whose degree of curvature begins with 0 on the tangent, and increases uniformly until the circle is met. There is also but one neat way of laying out this curve, and that is by deflection angles, similar to the way circular curves are laid out. Any method employing the use of parallel tangents or offsets is clumsy to say the least. Although these two points are clearly brought out in Mr. Holbrook's article I think they should receive a little emphasis.

Several years ago I became interested in the subject of transition curves, but was unable to find in my literature then available any method for laying them out founded on correct theory, and simple in execution. I accordingly worked out a spiral based upon the principle stated above, the formulas obtained being identical with those given by Mr. Holbrook, although reached by a somewhat different method. It seems to be one of those cases in which the simplest is the best; for there is certainly no simpler method of laying out the transition curve than the one here proposed. Mr. Holbrook's Table No. 1 is all that is necessary. In fact it could be still further simplified by eliminating the columns X, Y and Y_0. The column X is useless in view of what follows below; and Y and Y_0 are near enough for all practical purposes equal to L and ½ L, respectively.

There is one point, however, which Mr. Holbrook does not make very clear. He shows how to run the spiral from A to B, on the accompanying figure, providing it can all be run with the instrument at A. But he does not show how to run from D to F, nor from B to C, or E to F, in case it is necessary to set intermediate points between the beginning and end of spiral, except to say that the deflection angles may be calculated by means of the co-ordinates which he gives in his table. I think he will admit himself that this is clumsy.

There is an interesting and important property of this spiral that renders the above problem very simple, which I do not believe Mr. Holbrook knows. I was not able to read this property from my formulæ until several years after they were worked out, when my attention was called to it by reading an article written by Mr. E. L. Woolley, formerly of the Burlington railway in Nebraska. The property referred to is this: The deflection from tangent at any point on the spiral to any other point on spiral is equal to the deflection of a circular curve for same distance, whose curvature is equivalent to the curvature of spiral at said tangent point, plus or minus the deflection for an equal distance from the initial point on the spiral, according as the spiral is being run toward or from the central curve.

An example will illustrate more clearly. Suppose it be required to run a 4° curve with spirals increasing at the rate of 1′ per ft., and the initial point be established at Sta. 122 + 80, as shown in the figure above. By Mr. Holbrook's Table No. 1 the spiral will be 240 ft. long, and will connect with the central curve at Sta. 125 + 20. Suppose the other end of central curve be found at Sta. 131 + 60. Then spiral will unite with tangent at Sta. 134.

To run this curve the transit is set first at A, and the

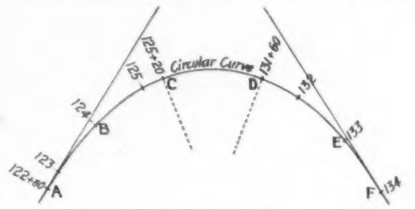


Diagram Showing Method of Laying Out Spiral Curves.

deflections to points between A and C, taken directly from the table as follows:

Sta. 123... 20 ft.	0° 00.7′	Sta. 125.....220 ft.	1° 20.7′
Sta. 124...120 ft.	0° 24.0′	Sta. 125+20.240 ft.	1° 36.0′

In case there is some obstruction in the line of sight it may be necessary to set an intermediate point, B, say at Sta. 124. The instrument is then moved to B and set on tangent by turning twice the angle from A that was turned from A to B, or 3° 12′. Then for deflections from B to C, since the spiral has attained a curvature of 2° per hundred feet at B, we have according to the property stated above:

For Sta. 125: Deflection of 2° curve for 100 ft. =	1° 00.0′
Plus deflection of spiral for 100 ft. (by table)..	16.7′
Total	1° 16.7′
For Sta. 125 + 20:	
Deflection of 2° curve for 120 ft.	1° 12.0′
Plus deflection of spiral for 120 ft. (by table)..	24.0′
Total	1° 36.0′

The transit is then moved to C. Back sight is taken on B, and to turn tangent we have, since curvature has become 4° at C:

Deflection of 4° curve for 120 ft.	2° 24′
Minus deflection of spiral for 120 ft. (by table)..	24′
Total	2° 00′

This circular curve is then run to D. Then with transit set at D and on tangent line at this point, we have for deflections between D and F, since curvature is here 4°:

For Sta. 132:	
Deflection of 4° curve for 40 ft.	0° 48.0′
Minus deflection of spiral for 40 ft. (by table).	02.7′
Total	0° 45.3′
For Sta. 133:	
Deflection of 4° curve for 140 ft.	2° 48.0′
Minus deflection of spiral for 140 ft. (by table)	32.7′
Total	2° 15.3′
For Sta. 134:	
Deflection of 4° curve for 240 ft.	4° 48.0′
Minus deflection of spiral for 240 ft. (by table)	1° 36.0′
Total	3° 12.0′

Had a point been placed at E and the transit set at this point, we would backsight upon D, and to turn tangent, since spiral has a curvature of 1° 40′ at this point, we would have:

Deflection of 1° 40′ curve for 140 ft.	1° 10.0′
Plus deflection of spiral for 140 ft. (by table).	32.7′
Total	1° 42.7′

Then, to finish the curve we have following deflection:

For Sta. 134:	
Deflection of 1° 40′ curve for 100 ft.	0° 50.0′
Minus deflection of spiral for 100 ft. (by table)	16.7′
Total	0° 33.3′

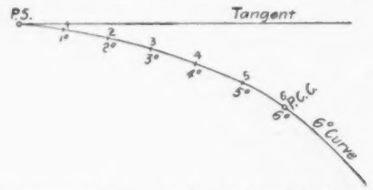
I think Mr. Holbrook underrates the elasticity of his method; for it is practically universal. His Table No. 1, gives the elements of what I denominate a No. 1 spiral, and the corresponding elements of a spiral of any number can be obtained by proportion. The number may be any quantity within practical limits, whole or fractional. Ordinarily it will not exceed 2 or 3, but in rough mountainous country, where sharp curvature is used, it might become necessary to use No. 6, or No. 8 spirals in special cases. These can be readily laid out with the table of elements of a No. 1 spiral, just as any circular curve is calculated from a table of elements of a 1° curve. The spiral thereby becomes as elastic as the circular curve.

Very truly, W. C. Armstrong,
Resident Engineer, Chicago & Northwestern Ry.
Clinton, Ia., July 11, 1901.

Sir: In your issue of June 13, I notice an article by Mr. E. Holbrook on the Railroad Spiral. Prof. Arthur N. Talbot, of the University of Illinois, has published a pamphlet on this subject, which he calls "The Railway Transition Spiral," containing 64 pages, which gives the theory of the spiral, with 11 pages of tables. This is the same curve which Mr. Holbrook claims to have discovered 20 years ago. I have used Professor Talbot's book for about a year and I prefer it to any other.

Mr. Holbrook says 1° in 30 ft. and 1° in 60 ft. are the only rates of change necessary. I make use of rates varying from 1° in 20 ft. to 1° in 100 ft., according to conditions to be met. Professor Talbot's tables are between these limits with all the properties of each, giving the numerical values necessary for laying out the curves in the field.

The deflection angles are easily calculated without the tables, for they are practically as the square of the distance along the spiral. The deflection angle for the whole length of the spiral is one-third of that for the circular curve for the same distance. Thus, for a 4° curve with spirals 400 ft. long the angle is one-third of 8°, or 2° 40'. Now, if we wish to put in stakes every 50 ft. the deflections will be as follows: 2½', 10', 22½', 40', 1° 02½', and so on directly as the square of the disance.



If you are on location and wish to put in the regular station stakes, use Talbot's tables and interpolate by inspection.

Mr. Holbrook says no case has occurred to him where he could not run in the entire spiral with one "set up." He must have worked in a very smooth country or else used very short spirals. It is a simple matter, however, to move up on the spiral in the same manner as on a circular curve. The spiral curve is the same distance from the tangent and from the circular arc produced at equal distances from the extremities of the spiral. This principle has been demonstrated by half a dozen writers.

It is by making use of the above principle that we are enabled to run in the spiral from any point on the curve, which can be shown best by an example. We will make the spiral long, for illustration. Take a 6° curve and the spiral 600 ft. long, and suppose that we have to move the instrument to Sta. 4, to run in the rest of the curve. The deflections to Sta. 4 are as follows:

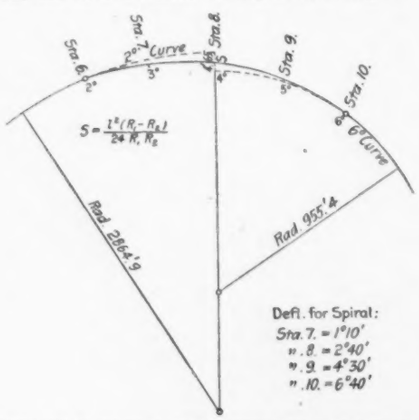
Sta.	Def.	Angles.
0	0	0
1	0°	10'
2	0°	40'
3	1°	30'
4	2°	40'

Move the instrument to Sta. 4, back sight on 0 with vernier set at 5° 20' (double the angle for this station); the deflections from Sta. 4 which point corresponds to a 4° curve. The deflections for the rest of the curve are as follows: Sta. 5 def. for 100 ft. of 4° curve is 2° and 100 ft. of the spiral is 10', so the total def. from tangent at Sta. 4 for Sta. 5 is 2° 10', for Sta. 6 it is 4° 40'.

Now let us run in the curve from Sta. 6 towards 0. We have the following table:

Sta.	Defs. for 6° curve.		Defs. for spiral from tangent.		Defs. for spiral from curve.
6	00 00	=	00 00	=	00 00
5	3° 00	=	00° 10'	=	2° 50'
4	6° 00	=	00° 40'	=	5° 20'
3	9° 00	=	1° 30'	=	7° 30'
2	12° 00	=	2° 40'	=	9° 20'
1	15° 00	=	4° 10'	=	10° 50'
0	18° 00	=	6° 00'	=	12° 00'

The same principle may be employed to connect the arcs of compound curves. For example, take a 2° and a 6° compound curve to connect with a spiral 400 ft. long. The



offset will be the same as a 4° curve from a tangent, viz., 4.65 ft., 4° being the difference between a 2° and a 6° curve.

	Def. for spiral.
Sta. 7	1° 10'
" 8	2° 40'
" 9	4° 30'
" 10	6° 40'

There are any number of special cases which will come up especially on old track, but usually the work is independent of the spirals and therefore no part of this subject.

Yours truly, W. H. Sadler, Assistant Engineer.

Windsor, N. Y., July 26, 1901.

MACHINE FOR LOADING BOX CARS.*

The purpose of this machine is to increase the actual load of box cars carrying material shipped in bulk by distributing the material over the whole length of the car, without the aid of manual labor.

The construction and operation of the machine in loading coal are well shown in the accompanying drawings. Fig. 1 is an elevation from the side, and Fig. 2 is an elevation from the end of the car, while Fig. 3 shows the hopper and the unloading mechanism. All the figures are reproduced from the patent drawings. The machine is mounted on a masonry foundation built close to the loading track, the coal chute being on the opposite side of the track. The metal pedestals A, A, carry the traveling bed plate or frame of the machine, B, by means of roller bearings, C. The frame consists of a pair of I-beams, and the pedestals also carry the smaller rollers, D, which bear upon the top of the lower flanges and prevent the frame from tilting. The operating engine, E, is mounted below the frame, the engine and gearing being protected by the hood or shield, F. Attached to the pedestals on one side is a long cylinder, G, and the head of the piston rod is attached to a heavy lug, H, at the end of the frame, by which means the frame is made to travel on the rollers.

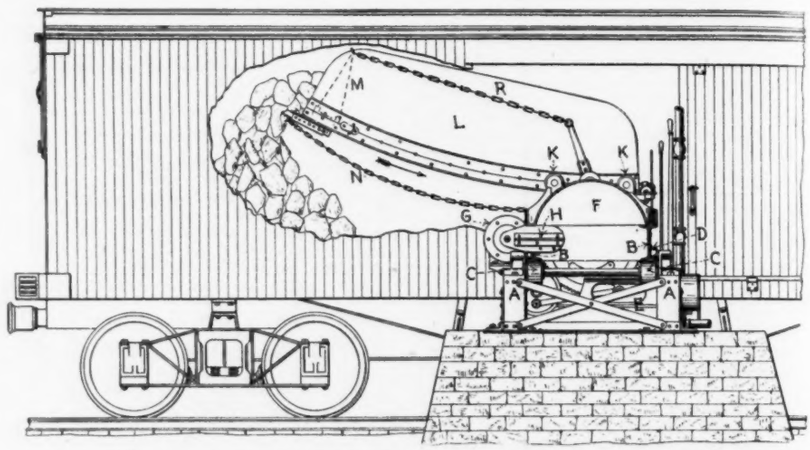


FIG. 1. SIDE ELEVATION OF BOX-CAR LOADING MACHINE IN PLACE.
Ottumwa Box-Car Loader Co., Ottumwa, Ia., Makers.

At the outer end of the frame is a circular casting fitting between the I-beams, and having around its top a groove for anti-friction balls, upon which rests the turntable, J, of the conveyor. The turntable has rollers, K, which carry the hopper, L, and enable the latter to be moved laterally. Upon the turntable is a locking pin, which automatically locks and releases the hopper as it makes its reciprocating motion lengthwise of the car.

The hopper receives its load intermittently and discharges it at opposite ends of the car alternately. The bottom is curved, and it consequently travels in a curved path, so that the delivery end (at either end of the car) is always higher than the receiving end, and consequently the coal is piled higher in the ends of the car than would be the case if the hopper traveled in a horizontal path. Within the hopper is a traveling pusher or gate, M, attached to a chain, N, which passes over guide pulleys and around a sprocket wheel, O, on the shaft, P. Another chain, R, passes from the top of the pusher to a lever operating the locking pin, and as the chain tightens at the end or the travel of the pusher, it releases the lock, and the hopper travels backward, receiving coal from the chute during its movement, the end gate remaining at what was the delivery end. When the hopper reaches the end of its travel, it extends towards the opposite end of the car, and is locked in position. The pusher is now forced along it, discharging the coal into that end of the car. The lock is again released, and the hopper moves back again, receiving another load of coal, which is again discharged by means of the pusher. The shaft, P, is driven by gearing by the double cylinder reversing engine, E.

When a car is put in place on the loading track, the frame is moved forward, the hopper being turned at such an angle as to enter the door. The frame being in position, the hopper is turned parallel with the side of the car, and the machine is then ready for operation. When the machine is withdrawn, the middle of the car may be loaded directly from the chute.

This machine is the invention of Henry Phillips and William Hunt, of Ottumwa, O., and is manufactured by the Ottumwa Box Car Loader Co., of that city, to which concern we are indebted for information. It is in use by a number of coal companies and by the Hocking Valley Ry.

*A machine of a different type for loading box cars, used in the Tennessee phosphate district, was described in our issue of June 16, 1898.

THE DECOMPOSITION OF CEMENT BY SEA-WATER.

Last July, at Paris, Mr. H. Le Chatelier presented before the International Congress on methods of testing materials of construction, a paper discussing the decomposition of cement by sea-water. The author commences by saying that our exact knowledge concerning the destruction of cement exposed to the influence of sea-water amounts to very little. We owe almost all we do know to the labors of Vicat, now out of date, and to the more recent studies and experiments of Candlot. Vicat regarded the decomposition of cement exposed to sea-water as exclusively chemical in its character; but his successors have abandoned this point of view, and have concentrated their efforts upon a study of the mechanical properties of the cements.

According to Vicat, the stability of masonry exposed to sea-water depended upon one of the two following conditions: First, the superficial formation of an impenetrable skin, due to the hardening of the cement, combined with the development of vegetation and marine shells. The formation of this hard outer skin depends upon the nature of the cement, the composition of the sea-water and climatic conditions. Well built up it opposes itself to all penetration by the magnesium salts contained in the sea-water; even though the thickness of the skin is not more than a few millimeters. The second condition is the simultaneous reaction of the magnesium salts and the carbonic acid; in such a fashion as to lead, without disintegration, to a complete chemical transformation in the mass of the cement.

This second condition is only filled by a very small number of hydraulic products, as follows: I. Cements of over 0.80, or those in which the weight of the silicate of alumina is greater than

8-10 of the weight of the line. II. The eminently hydraulic lines, holding very little alumina. III. Some mortars of puzzolano, made with a proportion of lime less than one-fifth of the weight of the puzzolano. Vicat undertook to manufacture a "maritime" cement, especially adapted for use in sea construction; and by order of the Minister of Marine, Sept. 6, 1858, this cement, in test blocks, was placed in different ports of France. One of these blocks is still in a perfect state in the harbor of Rochelle; but the death of Vicat, soon after these experiments were commenced, caused them to be abandoned; and the author says that it was very difficult to procure even the meager notes here given.

This Vicat "maritime" cement set in 45 minutes and had a density of 780 grammes to the liter. It was very like an artificial cement that was lightly burned. An analysis of the block now at Rochelle gives the following:

Silica	21.7
Alumina	3.4
Oxide of iron	2.5
Lime	32.6
Magnesia	3.7
Chloride of sodium	0.6
Sulphuric acid	1.2
Carbonic acid	7.4
Water	26.7
	99.8

Another block of this cement, submerged at Cherbourg, was put in the water 48 hours after it was made, contrary to the advice of Mr. Vicat, and it was destroyed by the wave shock in the night following its immersion. The Rochelle block, on the contrary, was allowed to harden for three months before immersion. A block of English Portland cement, submerged at the same time at Rochelle, still remains there; but it is so covered with a thick layer of oyster shells that the cement is completely masked.

The writer obtained fragments of cement from the interior of these two blocks and submitted them to the prolonged action of sulphate of magnesia. The Vicat cement remained unaltered under this test, while the English cement was rapidly destroyed. The preservation of these two blocks is thus due to the two conditions mentioned by Vicat; the one by the formation of a protecting skin by the action of living animals; the other by chemical resistance properly so-called. Vicat also pointed out the powerful influence of the porosity of the mortar upon the rapidity of its decomposition. He claimed that the action of the sea-water was principally due to the presence of sulphate of magnesia, and showed that solution of this salt, in the proportion of 4 or 5 grammes of anhydrous salt to the liter, would have almost the same effect as sea-water. He proposed to study the chemical resistance of cements by immersing in such a solution small briquettes with sharp angles, having first carefully removed the superficial skin of carbonated matter.

Mr. Le Chatelier then describes his methods of test and tabulates the results. In referring to these tests he says that the similar results obtained with solutions of sulphate of lime, sulphate of magnesia and sulphate of ammonia compel us to attribute a preponderating rate in the decomposition of the cement to the presence of sulphuric acid; and that the sulphate of lime does the most mischief. The salts of magnesia and ammonia are, in effect, immediately transformed into the salt of lime, and the author has noted this effect in a number of cases, where he found on analysis of decomposed cement a large proportion of sulphate. He then took briquettes made of a large number of different cements, allowed them to set for 14 to 28 days, ground them up and then mixed them with half their weight of sulphate of lime. The result was an enormous and very rapid swelling. In repeating these experiments with cements aged two months, the swelling was still greater and more uniform: for example, an English Portland cement, which gave previously 1.5% of swelling, give 12% after it has hardened sufficiently long to be considered as fully set.

In regard to the action of puzzolano-like matter, the author says that the diminution of the lime in cements, burned at a high temperature, is very soon limited by the formation of a heavy dust, which takes away from the product all its qualities of mechanical resistance. But we are able to reduce the proportion of free lime by introducing puzzolano-like material; and it was supposed that by such a compound decomposition could be stopped. To test this statement the author took cements known to be very easily decomposed in sea-water and mixed them with an equal weight of calcined precipitated silica, or with clay dehydrated or burned at 600° C. After hardening for 15 days these briquettes were immersed in an artificial saline solution. At the end of two months these briquettes were examined, and the result showed the absolute efficacy of the addition of silica, while the specimens to which dehydrated clay were added showed a reverse effect. Vicat, however, has said that the employment of baked clay would furnish a mortar strongly resisting the action of sea-water, but he recommends baking the clay at a temperature of 800° instead of 600°, as above, and the author proposed to make a new set of experiments on that basis. After baking the clay at this temperature, it is much less easily dissolved in the acids, but it would probably less easily enter into combination with the lime.

In discussing the mechanism of the disintegration of cements by sea-water, the author says that it is well known that the transformation of hydraulic material is accompanied by changes of volume more or less important. But the results obtained seem, at first view, to be contradictory, because we usually neglect to make the indispensable distinction between the apparent and the absolute volume. We suppose that these volumes ought to vary in the same manner; but this is not only not necessary, but it is contrary to what actually takes place. The apparent voulme of a pot of cement includes the volume bounded by the limiting surfaces of this mass; it is the sum of the solid cement, the liquid water and the imprisoned gas. On the other hand, the absolute volume is the sum of the solid matter and of the water included; the enclosed gas being excluded. The apparent volume is exclusively determined by the relative positions of the different solid particles; it will be increased if these particles are removed further from each other. We know that the hydration of lime is accompanied by an apparent swelling, and the small particles of free lime in a cement are sufficient to cause a notable swelling. And we can thus admit, as a general fact, that the transformation of hydraulic matter is accompanied by an augmentation of the apparent volumes.

Mr. Le Chatelier then constructed the apparatus for measuring the relative variations of the cement in absolute volume. This apparatus was somewhat like a large glass thermometer. As a result he found that the absolute volume was diminished, while the apparent volume was increased. But he does not attempt to explain either phenomenon under the conditions imposed.

To explain the disintegration of mortar by the sea, it is not sufficient to have established the variation of apparent volume resulting from the formation of sulfo-aluminate of lime; it is necessary to oppose some obstacle to this change of volume and thus provoke the development of a sufficiently energetic force. This force is generated in the hydration of the lime and the magnesia; and we know that in a closed vessel they will develop enormous pressures and finally break the envelope. But it is an important fact that this rupture often only occurs after the lapse of a very long time. Mr. Le Chatelier then explains disintegration by saying that the forces developed by the extinction of the lime and the magnesia, and by the combination of sulfo-aluminate of lime, in all cases where these forces are not sufficient to provoke immediate rupture, at first occasion only elastic tension. The elements constituting the cement thus put into tension increase in soluability; they dissolved and recrystalize immediately in places outside this tension. The elastic deformation is transformed by this process into permanent deformation; it develops very slowly owing to the feeble soluability of the silicates and aluminates of lime; but this phenomenon if prolonged for a sufficient time will finally lead to rupture. Thus the mechanical effects follow chemical causes, but at a very considerable distance in time.

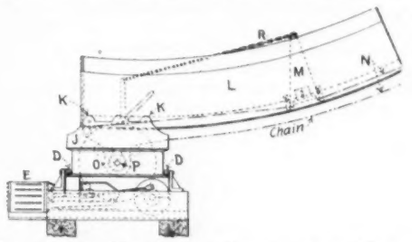


Fig. 3. Side Elevation of Hopper Mechanism of Box-Car Loading Machine.

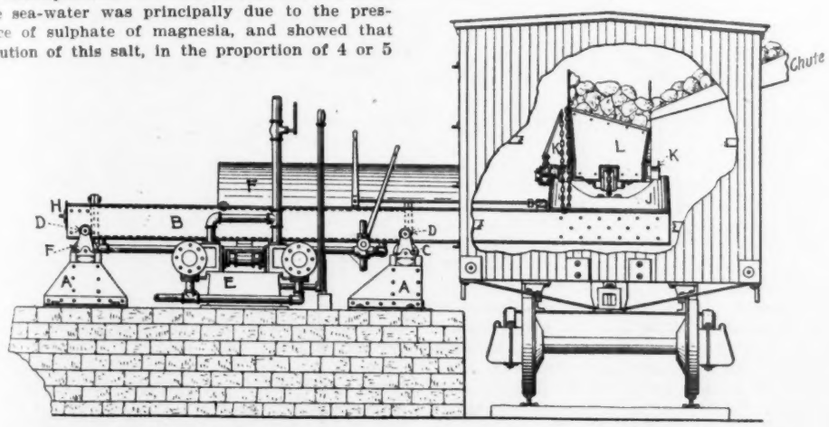


FIG. 2. END ELEVATION OF BOX-CAR LOADING MACHINE.

In conclusion, Mr. Le Chatelier says that he believes that we can assume the following facts as proven:

(1) The greatly preponderating, if not the only cause of the decomposition of cements in sea-water, is the formation of sulfo-aluminate of lime.

(2) The presence of alumina in the cements is the first cause of their decomposition. This alumina becomes dangerous as the proportion approaches 4%; it being understood that this statement applies only to active alumina, or that entering into combinations susceptible of being hydrated.

(3) The substitution of iron for alumina is advantageous from every point of view. The iron is a better flux than the alumina, and will not swell in contact with sulphate of lime. The mechanical resistance of ferruginous cements is much greater than that of aluminous cements.

(4) The danger from alumina is reduced by a reduction in the proportion of lime; but we are limited in this direction by the corresponding lowering of the mechanical resistance.

(5) The danger from alumina may seemingly be completely removed by the addition of silicious puzzolano; this danger is decreased by all the puzzolanos, and particularly by the cinders of combustibles. Portland cements containing cinders are seemingly less affected by sea-water than the cements made from pure rock.

WATER-WORKS FOR THE C. R. BAIRD CO.'S IRON MINES AT OGDEN, VA.

By John N. Ambler.*

Operations at the Griffin Mines, near Roanoke, Va., having been greatly hampered by a lack of water for use in the ore washers, it was deemed advisable in the spring of 1900 to make thorough surveys of the drainage areas south of Roanoke, to determine what source of supply would combine the advantages of low first cost and economy of operation of the works to be installed. The situation was a perplexing one, due to the scarcity of streams of any size, the great variations in their flow, their distance from the mines, and the exceedingly broken and mountainous character of the whole region.

At the instance of Mr. Arthur S. Hobby, M. Am Soc. C. E., then consulting engineer for the company, the writer undertook the necessary surveys which covered the entire region with a network of transit and level lines. This examination was conducted in a more elaborate manner than is necessary in most works of this character, the exigencies of this case demanding it. Due to the time given to thoroughness in this part of the work, the consulting engineer was enabled to reject several preconceived plans which would have involved great expense to the company, and was enabled to design works that would be both adequate and economical.

These works comprised a battery of two Deming triplex power pumps, some 6,000 ft. of 6-in. cast-iron force main, through which the water was elevated 200 ft. to a point on the mountain, whence it could be run by gravity to the Griffin Mines, 5,000 ft. distant, and also to the Sproul Mines, 4,000 ft. distant, if future needs demanded it. A plan and profile of the works is shown herewith. The water from Murray's Run was diverted by a small dam, the suction of the pumps taking it from a pit excavated for the purpose.

The turns in the force main were made with one-eighth and one-sixteenth elbow joints, there being only one circular curve on the line. The alinement was accurately preserved and grade stakes set every 25 ft., thus insuring a perfectly smooth system of vertical curves for this main. One automatic air valve and one scour valve were employed. Probably more importance was attached to the alinement and to the vertical curves than is usual, as the large number of turns made necessary by right-of-way complications necessarily put a heavy resistance on the pumps.

The water at the upper end of the force main was received in a brick masonry well, laid in and plastered with natural cement. A depth of 2 ft. was considered necessary to protect the pipe from frost, so that little blasting was necessary in the trenches.

The distinctive feature of these works consists in the gravity main of 6-in. vitrified clay pipe, through which the water was conveyed from the summit to the mines.

There was a fall of about 50 ft. in a distance of rather over 5,000 ft., and the line was compelled to follow the right of way of the company's railroad between Sproul and Griffin mines.

The matter was complicated by the fact that the grade of this railroad was not a uniform one, but was broken into four or five sections of straight grade, with connecting vertical curves, the gradients being from 0.4 to somewhat over 2%, all but one rising in the same direction. There were also three long trestles, crossing deep ravines.

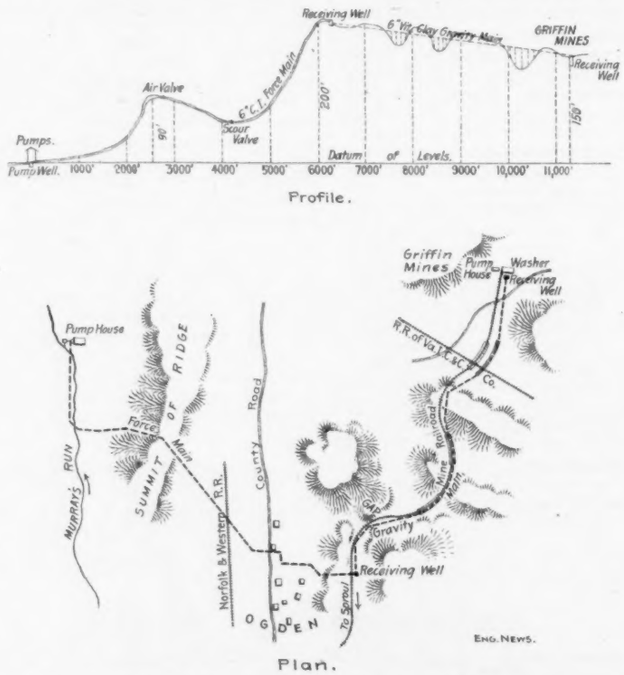
To avoid complications arising from the variations in discharge of pipe laid to different gradients, and to avoid subjecting the line to the pressure involved in the use of vertical curves, it was proposed that the vitrified clay pipe line should be laid with the uniform gradient of 1%, using masonry relief wells at every angle in the line, no horizontal curves being used. This involved several deep cuttings, and one or two shallow fills, it being usually impossible to leave the right of way. We had scarcely begun on the gravity line when the consulting engineer accepted a position, with a large water company operating in California, leaving the writer in charge of the work. It was decided to continue the pipe line sections on 1% grades, also to avoid some of the shallow cuttings and fills by dropping the grade vertically at several of the wells.

The original plan involved a well 18 × 18 ins. in plan, at each angle of the pipe line, there being a drop of 0.2 ft. in the grade for entrance head in each well. Since these wells were not large enough to serve as manholes, and since the hydraulic gradient could not be much above the actual grade of the pipe, when the grade was uniform and there was but little static head in the well at the entrance, the original plan was modified, in the interest of economy, so as to have a well only at such angles that the intervening stretches of pipe would be from 300 to 400 ft. long. In this way, even though an obstruction might occur, the pipes would not be subjected to a static pressure of more than about 6 ft., and the injury, if any, would be sufficiently localized, relief coming through the flooding of the well next above.

The first and second of these ravines were crossed by wooden flumes, resting on the ends of the cap-sills of the railroad trestles. Since these trestles were not on a 1% grade, the flumes were designed of such capacity as to handle the water which reached them, with such grades as the trestles had. The flumes connected with the pipe line at both ends in masonry wells. The loosening of these flumes by jarring of the trestles was thought of, but has not developed yet. It was found impossible to cross the third ravine on the railroad trestle, the grade of the track being some 12 ft. too low. A special trestle was designed to carry this flume. Its length is 451 ft., its center height is 30 ft., and it is laid on a 16° curve, so as to be concentric with the railroad trestle some 100 ft. distant.

The last section of the pipe line delivers the water into an old well at the Griffin mines. Here it is rehandled by a Worthington duplex pump, already installed, and abundance of water is now delivered through the entire system, with one of the pumps running at easy speed.

*Civil and Hydraulic Engineer, Roanoke College, Salem, Va.



PLAN AND PROFILE OF FORCE MAIN AND GRAVITY MAIN FOR THE WATER SUPPLY OF THE GRIFFIN MINES, OGDEN, VA.

A SYSTEM OF ELECTRIC RAILWAYS connecting Detroit and other cities of Michigan with Cleveland and Buffalo and ultimately with Pittsburg is being organized by the Everett-Moore syndicate of Cleveland, O. The syndicate has already secured control of 19 existing lines operating 1,213 miles of track and capitalized at $58,550,000. At no point between Detroit and Buffalo is there a gap of more than 20 miles not covered by existing lines and it is expected that by next summer the route will be continuous.

EFFECTS OF DAMS AND LIKE OBSTRUCTIONS IN SILT-BEARING STREAMS.

By Elmo G. Harris.*

Any effort to predict, numerically, the changes consequent upon an obstruction being placed in a natural stream is apt to be misleading. If such calculations must be based on certain definite numerical assumptions, and from the nature of such streams we know the conditions change frequently, both as to time and as to different parts of the stream. When a stream is obstructed some changes occur immediately, others gradually. In treatises on hydraulics may be found attempts to present formulas by which the immediate effects can be computed; but even if this could be done the problem remains unsolved until the gradual changes are taken into account. Of the two the latter are far more important.

The gradual changes are due to the inevitable deposit of silt that occurs in the pond caused by an obstruction. While we should not attempt to predict results numerically, we can, with confidence, foretell the kind of changes that will take place, and, neglecting time, can with satisfactory accuracy foretell the final results.

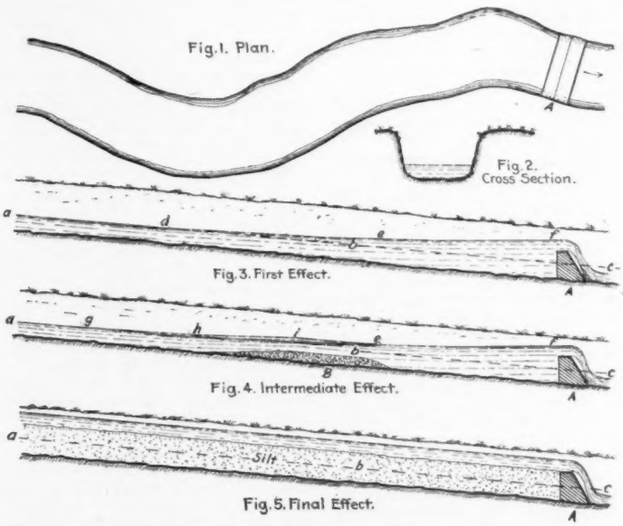
For the purpose of our present study, streams should be divided into two classes: (1) Those flowing by and over material that the water cannot cut away (as rock), and having, as compared with the second class, steep grades, resulting in frequent shoals and rapids. In this class there is little to study. An obstruction thrown across the stream will hold the water back on nearly a level line to intersect the slope of the shoal or rapid above. (2) Streams flowing through material that can be cut away by moving water, as the alluvium, or "bottom land." In such streams the running water will cut down and carry away the material until such a grade has been established and such a channel formed that no further radical change of either will occur so long as the stream suffers no interference. True, these streams are subject to freshets during which there are changes of quantity and of velocity which work temporary changes, but the stream will return to its normal condition as to grade and channel when the flow becomes normal.

In all natural streams there is silt. It varies in quantity from time to time in any one stream, and it varies in character in different streams, but in

*Professor of Civil Engineering, Schools of Mines and Metallurgy, University of Missouri, Rolla, Mo.

any stream of this second class, in its normal state, the velocity is just sufficient to keep moving such silt as may be delivered into it, but not sufficient to cut or erode the channel, for otherwise the stream would not have established its permanency as to grade and channel.

Let the accompanying Figs. 1, 2 and 3 represent respectively the plan and section of a stream in its normal state, and the profile just after an obstruction has been placed at A, and let Figs. 4 and 5 represent profiles of the same stream showing effects of the obstruction. Its first effect will be to pond the water immediately above, making a greater cross-section and a corresponding decrease in velocity. The grade line, or water surface line, on the profile will become some sort of curve d e f tangent to the original grade line a b c. This curve is the subject of some very intricate mathematical analyses by some writers on hydraulics, which, being determined to their satisfaction, they leave the subject as finished. They seem to overlook the fact that this is merely a transition stage. The more important changes now begin: The silt moving down in the temporarily unaffected part of the stream will be brought in to the ponded portion, where, owing



DIAGRAMS ILLUSTRATING THE EFFECT OF DAMS AND LIKE OBSTRUCTIONS IN SILT-BEARING STREAMS.

to the reduced velocity, it will come to rest, being distributed according to its size and specific gravity over some length of channel as at B, Fig. 4. In coming to rest, the bed of silt becomes itself an obstruction over which the flowing water must pass, and in doing so the surface is thrown higher than before the silt was deposited. Thus evidently this deposit of silt makes a new backwater curve, g h i, Fig. 4, independent of, and above that due to the original obstruction at A, and the region where silt will stop is thus thrown further upstream. It is now apparent that, assuming no change in volume of flow, the deposit of silt progresses upstream from near the head of the pond caused by the original obstruction, and that the filling-in will extend upstream to where the normal grade breaks into a steeper one, be that near or far. On the assumption that there is no change in volume of flow it will appear that no more drift can get to B (Fig. 4) until the channel above B is silted up to such a depth that B no longer appears as an obstruction, that is, until the stream has been elevated (top and bottom) parallel to itself a height equal to that of the deposit at B. At this stage silt will again pass over the region B, but will come to rest just below. Then the process above described will be repeated. The repetition will continue, each time raising the stream, bed and surface, parallel to itself, and shifting the point of deposit nearer to the original obstruction, until finally the stream will be raised parallel to itself a height equal to that of the original obstruction, as shown in Fig. 5.

To simplify and make clear the above discussion we have assumed that the quantity of water flowing is constant; that the cross-section of the water does not change, and that the silt is of uniform character. It is plain that none of these assumptions are correct, but no argument is needed to show that the varying conditions will not alter the final result, though the process will be less orderly than above described.

As a matter of fact, the silt, varying as it does in size and specific gravity, will be deposited simultaneously over quite a length of channel, and freshets may sweep through the channel, take up the silt, and deposit it again further into the pond, thus filling the pond first.

It should be observed that since the banks of all streams slope outward, the stream bed will widen as the bottom silts up, thus causing the water to either spread over more surface or to take a sinuous course. In either case an increase of friction and a corresponding decrease of velocity must occur, and this would increase the tendency to deposit silt.

If the obstruction is such as to finally raise the surface line to the bank level, the channel will be completely filled and the stream lost in a marsh; and this will not necessarily first occur near the obstruction.

It should be noticed that in raising the level of a lake or pond we, in effect, place an obstruction at the mouth of every stream entering therein, the height of the obstruction being equal to the rise of surface of the pond.

When an obstruction is removed from a stream, the change will be, of course, the reverse of what is described above.

The above conclusions may be restated briefly as follows: A stream flowing through alluvium will, by cutting away the material of its channel at some places, and silting up at others, finally establish for itself a definite slope, or grade, dependent on the volume of water flowing and on the character of the material through which the channel is cut. Any steeper grade will cause erosion; any less will allow deposit of silt. Hence such a stream must finally re-establish this definite grade after an obstruction has either been put in or taken out; in the former case by silting up, in the latter by cutting down. The new surface line being parallel to the first the change must extend upstream to where the first is broken, be that near or far.

The writer believes this subject not well understood, especially outside the engineering profession. It is of vital importance to agriculture along such streams, and it should be used with good effect in reaching decisions in suits for damage resulting from the erection of milldams and the like.

PRELIMINARY CONCLUSIONS OF THE BRITISH ROYAL COMMISSION ON SEWAGE DISPOSAL.

In 1898 there was appointed in England a Royal Commission on Sewage Disposal. It consisted of nine members, with Lord Iddesleigh at their head. The commission has held a number of hearings, considered the recent experimental and practical work in Great Britain, and inaugurated investigations of its own. Meanwhile English engineers and local authorities have been awaiting the report of the commission with the greatest interest. In many cases, it appears, the execution of important works has been postponed until something should be heard from the commission. That body has issued a preliminary report, in which it gives tentative answers to three questions. These relate (1) to the kinds of land available for sewage treatment; (2) whether the new bacterial processes, without subsequent land treatment, are sufficient; (3) what should be done in the way of better river protection. The conclusions on these three points are as follows:

(1) We doubt if any land is entirely useless, but in the case of stiff clay and peat lands the power to purify sewage seems to depend on the depth of the top soil. There are, of course, numerous gradations in the depths of top soil which are met with in nature, and it is not easy to draw the line between lands which contain a sufficient depth to justify their use and lands which do not. We are, however, forced to conclude that peat and stiff clay lands are generally unsuitable for the purification of sewage, that their use for this purpose is always attended with difficulty, and that where the depth of top soil is very small, say 6 ins. or less, the area of such lands which would be required for efficient purification would in certain cases be so great as to render land treatment impracticable. Further information with regard to this point will be available when our investigation of land treatment is completed.

(2) After carefully considering, however, the whole of the evidence, together with the results of our own work, we are satisfied that it is practicable to produce by artificial processes alone either from sewage, or from certain mixtures of sewage and trade refuse such, for example, as are met with at Leeds and Manchester, effluents which will not putrefy, which would be classed as good according to ordinary chemical standards, and which might be discharged into a stream without fear of creating a nuisance. We think, therefore, that there are cases in which the local government board would be justified in modifying, under proper safeguards, the present rule as regards the application of sewage to land. No general rule as to what these safeguards should be can be laid down at present, and, indeed, it will probably always be necessary that each case should be considered on its own merits.

(3) We consider it of the utmost importance that the simplest possible means should be provided for adequately protecting all our rivers, and we are further of opinion that it will be desirable, probably for some time to come, that scientific experiments should be carried on in order to ascertain all the real dangers of pollution, against which they should be protected. In the present state of knowledge, and especially of bacteriology, it is difficult to estimate these dangers with any accuracy, and it seems quite possible that they should be either exaggerated or undervalued according to the predisposition of those who have to deal with them. An authority guided by medical considerations might not unnaturally be inclined to insist on a degree of purity which may ultimately prove in certain cases to be uncalled for; while another authority, with its mind fixed upon economy, might shrink from taking essential precautions. It is perhaps scarcely for us to say what arrangements should be made, but we are of opinion that the general protection of our rivers is a matter of such grave concern as to demand the creation of a separate commission, or a new department of the local government board, which shall be a supreme rivers authority, dealing with matters relating to rivers and their purification, and which, when appeal is made to them, shall have power to take action in cases where the local authorities have failed to do so.

The first and third of these conclusions throw a strong side light on the status of sewage disposal and stream pollution in England. The first one indicates the straits to which English municipalities have been put to find suitable land, or one might say land of any sort, for sewage disposal. The third conclusion shows that after all that has been done and attempted to protect the inland waters of England, the results are still unsatisfactory, the principles involved uncertain and the need of a strong and competent central authority urgent.

But it is the second conclusion which has been awaited with eagerness for three years in Great Britain, and has been looked forward to with some concern in this country. The possibility of

effecting a satisfactory purification of sewage by such methods as the septic tank and rapid filter beds is guardedly recognized. This will be hailed with joy by hundreds of English communities and engineers who have hitherto been unable to secure approval from the Local Government Board for a loan for sewage purification unless provision was made for the old-fashioned methods of land treatment. Whether or not events will prove this joy to be well founded we do not attempt to say. Brief comment on this general subject will be found on our editorial page.

NAVAL AND MERCHANT SHIP CONSTRUCTION IN THE UNITED STATES DURING THE PAST YEAR.*

It may be said that, without probably a single exception, the yards in the United States that engage in building steel vessels have work ahead to their full capacity for at least 12 months and some of them for a much greater length of time. This is true of all ship yards of the seaboard, as well as those of the Great Lakes. On the seaboard the great bulk of work is in the construction of ships of war, but the demand for new vessels for coasting service, the most prominent feature in American ship-building during the past two or three years, still continues, and the coming year will see the completion of a few vessels for oversea commerce that will be among the finest in the world. These latter include two Pacific Mail liners nearing completion at the Newport News works, six large freighters for the Atlantic Transport Line at Camden, N. J., and at Sparrow's Point, Md., and two steamers at New London, Conn., for service on the Pacific in connection with the Great Northern Railway, that will be of about the same dimensions as the White Star liner "Celtic," the largest ship afloat.

In naval circles the year is distinguished by the fact that the largest order for new vessels of war ever awarded by the government was given to the ship builders. Contracts were awarded for 14 warships (five battleships, six armored cruisers and three protected cruisers), aggregating 187,354 tons in displacement, 297,120 in HP., and costing, exclusive of armor and armament, $49,944,000. Altogether, 61 warships are now building for the United States Navy, representing a total displacement of 289,183 tons, 567,620 HP., and costing, for hulls and machinery only, $80,954,-116. In addition, the last naval act authorized the construction of two battleships and two armored cruisers. The plans for these will be submitted to Congress at its next session by the Naval Board of Construction.

If there is any tendency to be noted in naval construction it is to further eliminate the line of demarcation between the battleship and armored cruiser. A battleship was originally a vessel with tremendous powers, offensive and defensive, and limited seagoing qualities; a cruiser was originally a vessel of limited powers, but of great speed and steaming radius. The tendency is to increase the cruising area of the battleship with sacrifice in the weight of armor or force of armament; and on the other hand to give to the cruiser a powerful battery and heavy belt of armor, with reduction in steaming radius. This form of warship, treating the two types as one, is very popular in the United States and Great Britain, as will be noted from a review of their programs. The protected cruiser, or commerce destroyer, of which the "Chateaurenault" of the French navy and the "Variag" of the Russian navy are the highest types, is not popular in the United States or Great Britain. The American navy's contribution to this type consists of the "Columbia" and "Minneapolis," but no more are building. As they have slight powers of offense and defense their chief security lies in their great speed. Speed must ever be regarded as an unknown quantity, since it is only under the most perfect conditions that the vessel can attain the maximum. The least derangement of the machinery would materially reduce the speed of the vessel. It is quite conceivable that an armored cruiser of 19 knots could overtake a commerce destroyer, and the issue, of course, could not then be in doubt.

The question of the superposed turret is still unsettled. The "Kearsarge" and "Kentucky" are equipped with this form of turret and several trials have proved them to be structurally practicable. The Naval Board of Construction, after heated arguments, decided to equip three of the five battleships with them, for which contracts were lately let, but it is clear that the board is not sure of the eventual utility of these turrets, for it has decided not to so equip the two battleships for which plans are now being prepared. The real point, indeed, is not the structural success of the turret but its vulnerability in actual conflict. If a chance shot would put the turret out of action it would leave the ship without a battery, even though the guns in the turret were uninjured.

As previously noted, a healthful growth is still shown in the seaboard coastwise trade. The present generation of ship builders have never enjoyed a season of such activity. To equal it one must go back to the clipper days of 1854 and 1855, before iron began to supplant wood in the construction of vessels, and when the American ship yards, thanks to the plentitude of constructive material, were great hives of industry. When iron was found to be more serviceable than wood the ship-building industry in the United States lagged because iron was scarce. The advance of the United States in recent years, however, as a steel-making nation has revived ship building. The coast ship yards are crowded with passenger and freight steamers, building for the coastwise trade. A considerable business is also being done in steel sailing vessels. Hitherto wood has had a monopoly of this class of construction. The sailing ship is not the rarity that it is supposed to be. It is only within the past year or two that steam tonnage has exceeded sailing tonnage in the United States. The proportion, however, is safely in favor of steam, owing to the fact that the sailing vessel has almost entirely disappeared from the Great Lakes. A novelty in sailing-ship construction has been the building of two six-masted schooners, the first vessels of this kind to be built anywhere in the world. The number of vessels built during the year ended June 30, 1901, was 1,173 of 401,285 gross tons, compared with 1,098 of 305,677 gross tons for the previous fiscal year. The distribution was as follows: Atlantic and gulf coasts, 735 vessels of 190,948 tons; Great Lakes, 105 of 153,138 gross tons; Pacific coast, 151 of 46,105 gross tons; and Western rivers, 182 of 11,094 gross tons.

Although there is little to report regarding vessel construction for the foreign trade, it will be noted that the year has brought out a few orders from new sources. The Atlantic Transport Line is now in the front rank in this regard. It has given the New York Ship Building Co., Camden, N. J., contracts for four steamers for transatlantic service to cost $1,250,000 each, and the Maryland Steel Co., Sparrow's Point, Md., contracts for two others to cost a similar sum. The Boston Steamship Co., a new organization, also exhibits a like bravery and has two vessels under construction for the foreign trade.

A venture of far-reaching interest attempted on the Great Lakes is worthy of record. It is the opening of the all-water route from the Great Lakes to Europe, via the Canadian canals along the St. Lawrence River. As a matter of historical record it may be noted that although a few small craft made the passage from the lakes to European ports years ago, the first vessel to utilize these enlarged Canadian canals as a commercial highway between the Great Lakes and Europe was the British steamer "Monkshaven," when in October last it carried a cargo of steel from Conneaut on Lake Erie to Avonmouth, England. This vessel had been employed by the Clergue water-power interests at Sault Ste. Marie, and was returning to Great Britain for the winter when Mr. Carnegie seized the opportunity to send some steel abroad by that route. The vessel would have returned to England anyhow, but her trip constituted, nevertheless, the first use of the canals in a commercial sense. Since then the Northwestern Steamship Co. of Chicago has opened a regular service on this route and its four steamships, built at Chicago last winter, have each made a trip abroad. The dimensions of the locks of the Canadian canals are 270 ft. length by 45 ft. width. They permit a draft of 14 ft. The vessels of the Northwestern Steamship Co. are 256 ft. long over all, 42 ft. beam and 26½ ft. depth of hold, which is regarded as the regulation Canadian canal size. The company expresses itself as satisfied with the results of its enterprise. The importance of this waterway, however, must not be either magnified nor minimized. It occupies a definite field, though a limited one, owing to the restriction in size. The completion of the canals, however, has permitted the lake ship builders to compete with the coast ship builders for the construction of some types of vessels for coastwise trade. Twelve vessels suited to transatlantic and seaboard trade, as well as lake service, were built on the lakes during the year ended with July, 1901, and the experiment of building in two parts two steamers much larger than the canal locks is now being being tried in Cleveland. These vessels will each be of about 7,000 tons capacity when put together at the seaboard, after being towed down the Canadian canals in sections.

The year has been one of unprecedented activity with the ship builders of the Great Lakes, and they already have in hand enough orders to insure continued work for nearly all the plants for another year. The vessels built during the year ended with July, and those now under order, have an aggregate value of $16,324,000. The combined capacity of the 63 freight carriers in the list is 266,950 gross tons on 18-ft. draft.

*Abstracted from the introduction to the "Blue Book of American Shipping."

THE GROWTH OF COMMERCE between the United States and Germany is shown by some figures recently issued by the United States Treasury Bureau of Statistics. The increase in imports from Germany during the past 30 years has been nearly 300%, while exports have increased nearly 400% during the same period. The greatest growth in exports has taken place during the last five years, during which time the exports of agricultural implements have risen from $356,914 to $2,677,319, and machinery of all kinds from $1,595,135 to $8,109,095. Of the imports the articles which have shown the greatest growth are coal-tar colors and dyes, chemicals, laces, earthenware and sugar. Coal-tar colors and dyes have increased from $1,272,275 in 1891 to $3,822,162 in 1900, and other chemicals from $1,868,988 to $3,968,116. The total imports and exports during the last 30 years are shown in the following table:

Fiscal year.	Imports into U. S. from Germany.	Exports from U. S. to Germany.
1870	$27,015,321	$42,[illegible]88,877
1875	40,247,712	40,[illegible]90,025
1880	52,211,237	57,[illegible]32,283
1885	63,241,753	62,[illegible]22,791
1890	98,837,683	85,[illegible]53,312
1891	97,316,383	92,[illegible]65,456
1892	82,907,553	105,[illegible]31,558
1893	96,210,203	83,[illegible]78,988
1894	69,387,905	92,[illegible]17,103
1895	81,014,065	92,[illegible]38,733
1896	94,240,833	97,[illegible]97,197
1897	111,210,614	125,246,088
1898	69,697,378	155,929,972
1899	84,225,777	155,772,179
1900	97,374,700	187,347,889
1901	100,293,666	191,072,252

JAPANESE TRADE IN 1900 is discussed by Consul-General E. C. Bellows, of Yokohama, in a recent report. The trade of Japan with the principal countries is shown in the following table:

Country.	Exports.	Imports.
United States	$26,178,064	$31,225,075
Great Britain	5,608,972	35,675,833
China	15,872,044	14,920,448
Hongkong	19,510,372	5,308,607
Germany	1,770,695	14,541,448
British India	4,334,760	11,711,142
France	9,536,910	4,031,717

In regard to engineering supplies and machinery the report says:

America still holds her supremacy in Japanese imports of bicycles and tricycles, and leads in electric-light apparatus, mining machinery, paper-making machinery, watch cases and watch movements, but is surpassed by Germany in clocks, weaving machinery, and sewing machines; by Great Britain, in fire engines and pumps, tools and implements of farmers and mechanics, photographic apparatus, locomotive engines, spinning machinery, steam boilers and engines, belting and hose for machinery, and turning lathes; by Belgium, in telephones; and by Switzerland, in watches. In all these except spinning and weaving machinery and watches, the United States stands second, and a comparison of the figures for 1900 and those of the previous years shows a very creditable increase of her exports to this country. In 1900, Japan paid $665,558.47 for railway passenger and freight cars, more than three-fourths of which went to Great Britain; the United States, which ranked second, receiving only $69,236.83.

A GOOD-ROADS CONGRESS is to be held at Buffalo, N. Y., Sept. 16 to 21, under the auspices of the U. S. Department of Agriculture (Office of Public Road Enquiries) and the National Good Roads Association. There will be papers read and discussed, and a part of the time will be devoted to the demonstration of modern methods of road making, including earth, gravel, stone, macadam, tar-macadam, etc. Brick paving will also be laid, and an illustration given of the use of oil on dirt and gravel roads. A train equipped with modern road-making machinery will also be on exhibition. The call for the congress was issued by the National Good Roads Association and signed by W. H. Moore, President, and R. W. Richardson, Secretary. The headquarters of the association are in the Marquette Building, Chicago, Ill.

THE ALFRED NOBEL PRIZE for the advancement of science has been awarded to Professor Finsen, of Denmark, for founding the light treatment of lupus, and to Professor Pavloff, the Russian physiologist, for his researches in nutrition.

ANOTHER DAM ACROSS THE MISSISSIPPI RIVER is reported as under construction. The builder is the Twin City Rapid Transit Co. The dam is to be located at Koon's Rapids, above Minneapolis.

BOOK REVIEWS.

HAND-BOOK OF FIRE PROTECTION FOR IMPROVED RISKS.—By Everett U. Crosby, Secretary and Treasurer National Fire Protection Assoc., etc., and Henry A. Fiske, Manager The Underwriters' Bureau of New England. Boston: Standard Publishing Co. Leather; 4½ × 7¼ ins.; pp. 312; illustrated.

Mr. Crosby in 1896 compiled a similar hand-book, which was distributed by the Underwriters' Bureau of New England, chiefly among its own members. The present volume is much more comprehensive, and is brought up to date. It is intended to meet the needs of those inspecting improved risks, as well as to advise the layman in matters relating to fire protection. The text illustrates and describes the construction and application of so-called fireproof floors, store-houses, doors and shutters, etc. It treats of wired glass, various forms of sprinklers and their installation, pipe fittings, alarm valves, steam pumps, tanks, etc. It gives rules for testing automatic sprinklers and describes the equipment of factory fire stations and the wiring of buildings for automatic fire alarm. The concluding chapters enumerate common and special hazards, and give a number of tables useful in connection with fire protection.